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SEE PAGE 746

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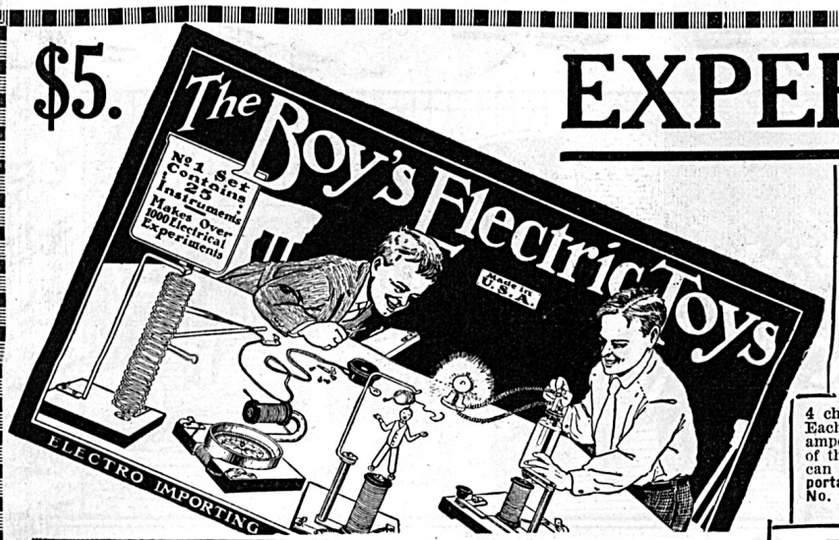

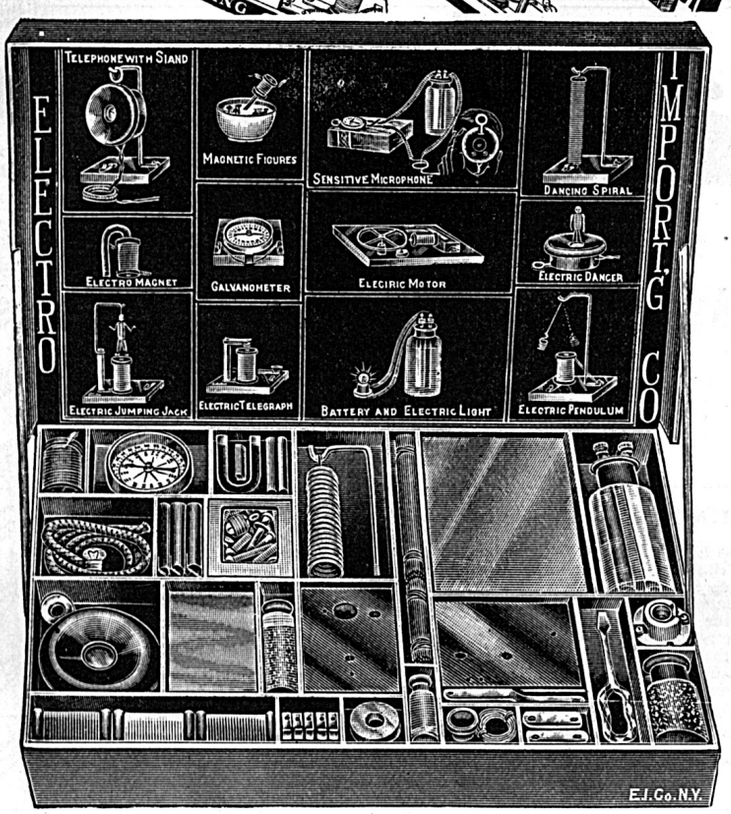

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This does not by any means exhaust the list, but a great many more apparatus can be built actually and effectually.

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No. EX2002 "The Boy's Electric Toys," outfit as described.....

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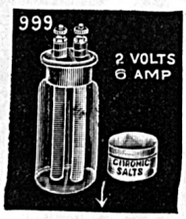

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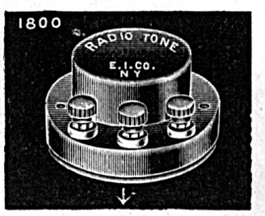

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Radiotone as described.....each **$.90**

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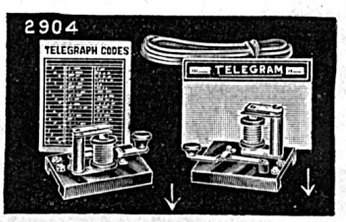
The "Electro" Telegraph



is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½ x 2½ x 2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back. **Price Complete as illustrated (TWO INSTRUMENTS).. $1.25**

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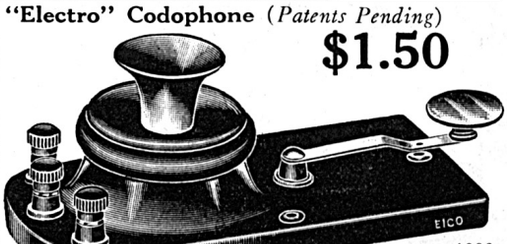

1999

The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver. The loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

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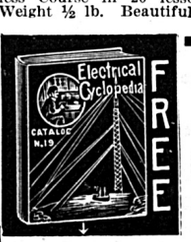

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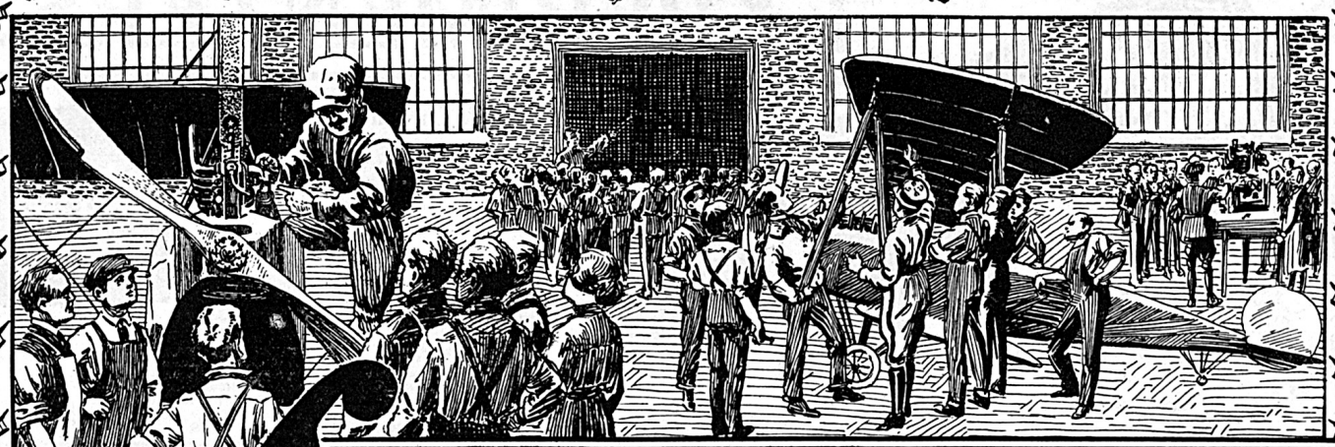

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Dormant Forces

DURING the past few months we have read a good deal in the daily press about a wonderful new force purported as having been discovered by an Armenian gentleman by the name of Garabed Giragossian. "Garabed," as the new "force" is now popularly known, is supposed to drive ships across the oceans at a fraction of the cost it is possible of doing the same thing now. Aeroplanes with a "handful" of Garabed will cross the Atlantic in a few hours, so we are told; in short, all our known notions of present-day energy-producers will be thrown on the ash-heap,—always providing that Mr. Giragossian will be able to make good his promise!

That the scientific press has kept itself aloof—never even mentioning the supposed invention—matters little. Scientific men quite properly like to deal with facts, not suppositious inventions. But Mr. Giragossian has been able to interest our Government, and at the present time five scientists of repute are looking into the merits of the "discovery." Whether Mr. Giragossian has actually made a great invention or not is beside the scope of this article. The point we wish to make is that the world, as far as cheap energy is concerned, still sleeps the sleep of the ages. We cannot even claim that the world in that respect is still in its infancy. It is much further back than that—it has not even been born. What are we to think of ourselves and our much-vaunted science when we contemplate the fact that, for instance, when burning coal to produce electric light we get 6/10 of 1% of useful light from the energy stored in our coal when we burn it, the other 99 4/10% being totally lost in useless heat which we don't want. Just think of the tremendous energy we expend in first mining coal, then hauling it over a thousand miles of rail, then transshipping it a dozen times, re-loading and unloading it before we finally drive an engine with the little heat we can actually extract from the coal. Is it not tantalizing to realize that the latent energy stored up in ¼ ounce of coal—theoretically—can haul a long train over one thousand miles! Atomic forces are so gigantic that we cannot begin to even comprehend them. All about us—in every stone, in all metals, in every piece of wood, every material in fact—billions of horsepowers are laying, locked up, dead and inert. The atomic energy locked up in a one-cent piece is sufficient to lift up the Woolworth building several thousand feet into the air. The only trouble is we do not as yet know how to unlock this tremendous energy. We are still blind towards atomic forces, just as blind as the savage is towards a cubic foot of Trinitrotoluol. It means nothing to him, for he can kick it around to his heart's content, without danger, and nothing will happen. Even if we did supply him with the necessary percussion cap it would not help him to unlock the 10,000 cubic feet of gas lying dormant in that one cubic foot of explosive. He would not know how to apply the cap, which perhaps is a good thing—for he would never have to try it again—at least not after his relatives had discovered his remains, miles away from the scene!

Some of the newspaper editors have ridiculed Mr. Giragossian, as they thought he meant perpetual motion by his perhaps rash term of "free energy." These worthy gentlemen evidently forget that their fathers some forty years ago talked in like terms when the Niagara Falls were first spoken of to run the street cars in Rochester and Syracuse—over 100 miles distant!

All this of course is ancient history now, but it is simply a conversion of a natural power, and "free" energy in a sense. For it costs man actually nothing; the power is there, all we need to do is tap it, and we do not have to expend additional energy in so tapping it either, as for instance we must do in mining and hauling and handling coal.

Of course, this tapping of our waterpower to-day is a barbarous procedure, one our grandchildren will laugh at; but for us it is as wonderful as it was for our forest ancestors when they tried laboriously to make a fire by rubbing dry wood sticks together.

But the new energy is coming as surely as the sun will rise to-morrow, and just as surely this force will make man free from most of his present physical drudgery.

H. GERNSBACK.

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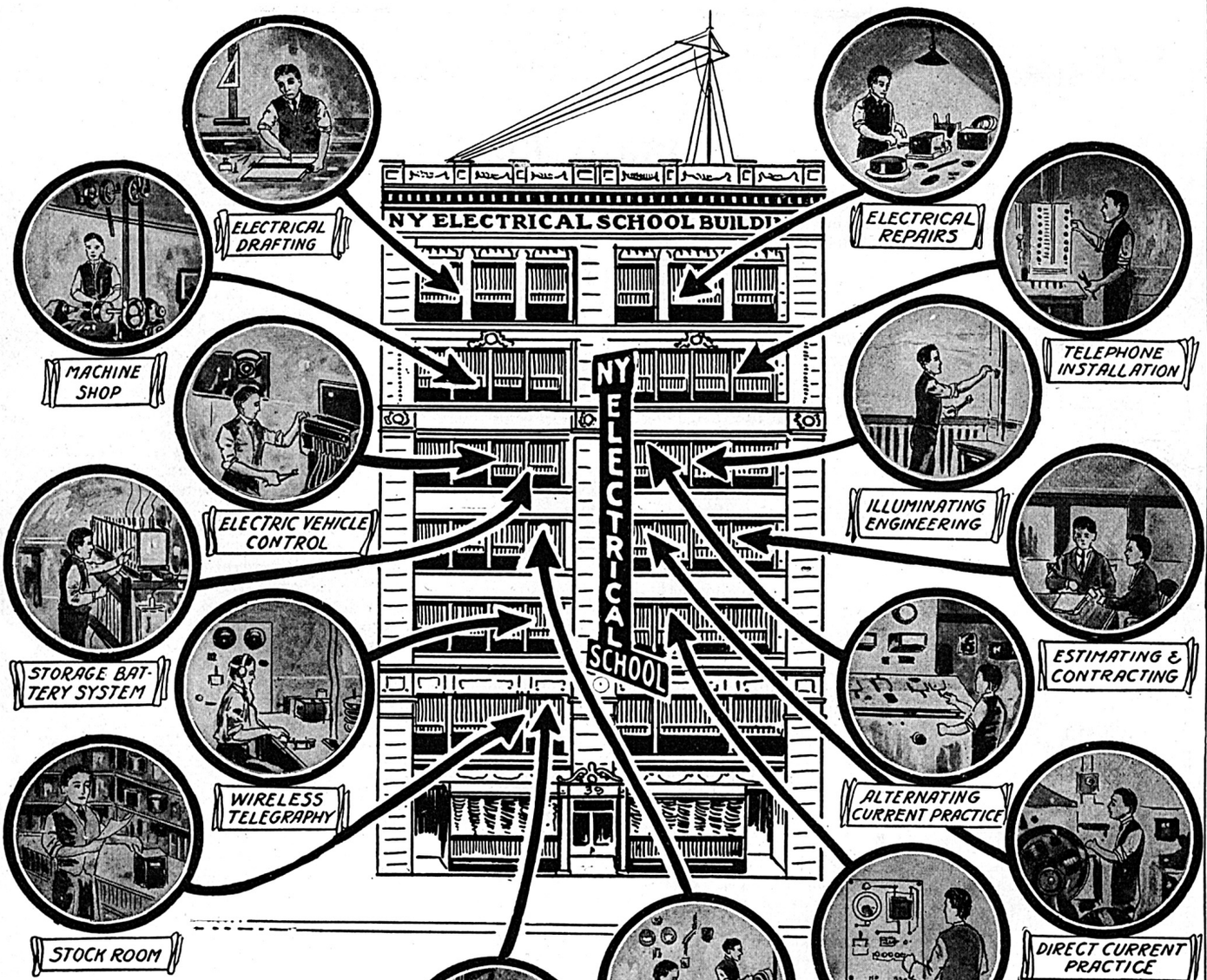

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ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 59 | March, 1918 | Number 11

President's Speech to World Via Cable and Radio

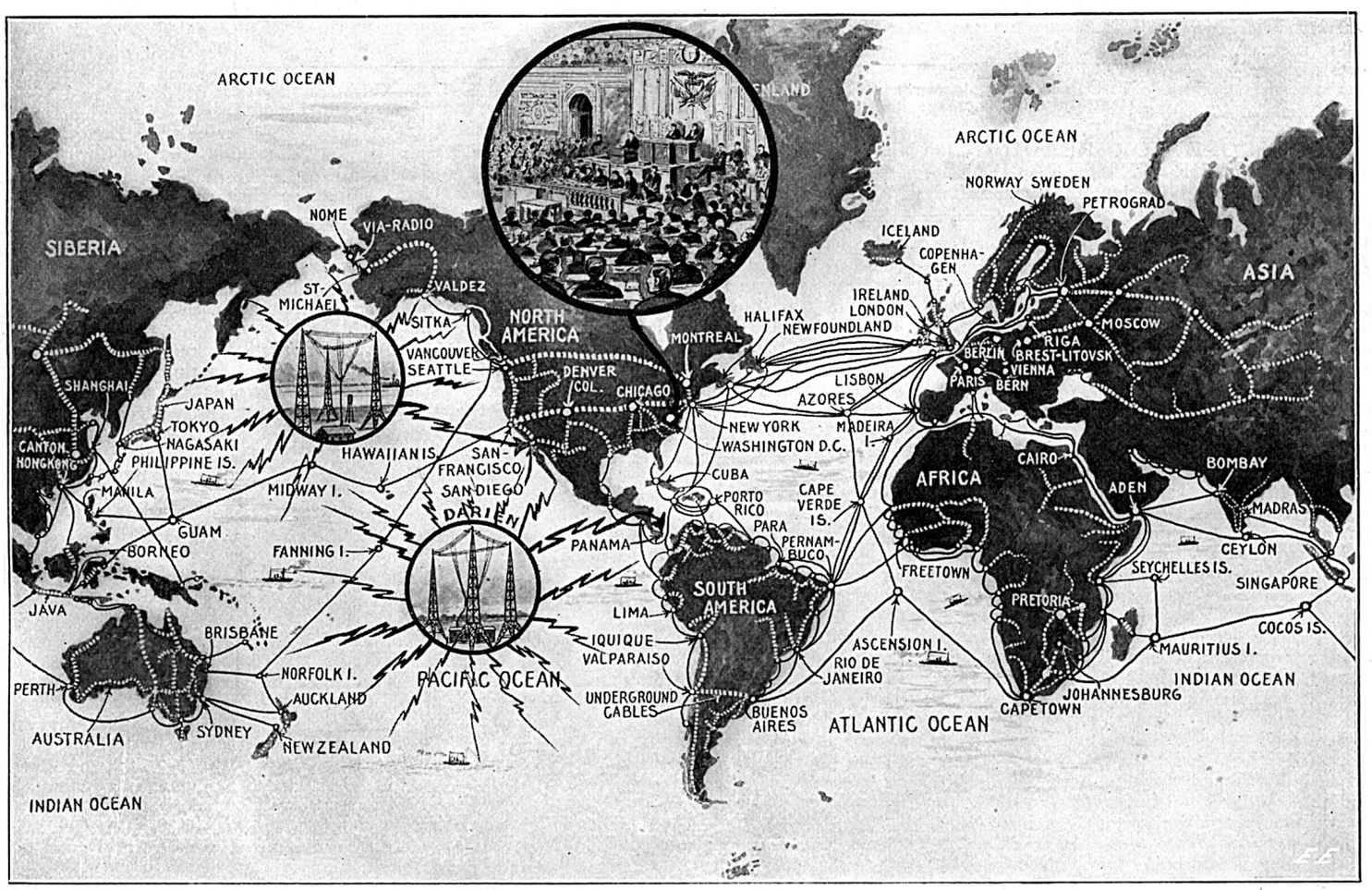
LITERALLY to the ends of the earth President Wilson's recent "Peace-terms" address was sped by cable, telegraph and radio as soon as he began it, and thru the newspapers of every civilized country the whole world's reading population has become acquainted with America's war aims in detail.

used for the transmission, and the operators at both ends were locked in their rooms lest by any chance there might be a leak as to the nature of the speech before Mr. Wilson delivered it.

Then, in order to insure absolute accuracy, the address was "read back" to Washington over a private long-distance

kept under lock and key or under naval guard. Advance information would have been almost priceless to Wall Street speculators.

At thirty minutes past noon the word came "Release President's speech," and the cable and telegraph operators started clicking it off to the four quarters of the globe.



Map of the World, Showing Principal Cables (Full Lines) and Land Lines (Dotted Lines) By Which President Wilson's Recent "Peace-terms" Address Was Broadcasted to Every Civilized Country as Soon as He Started Speaking at Washington. The Powerful U. S. Government Radio Stations at Darien and San Diego Flashed the Message to Ships at Sea and the Smaller Islands in the Caribbean.

This was one of the biggest and swiftest bits of news distribution on record, and it was done in this way:

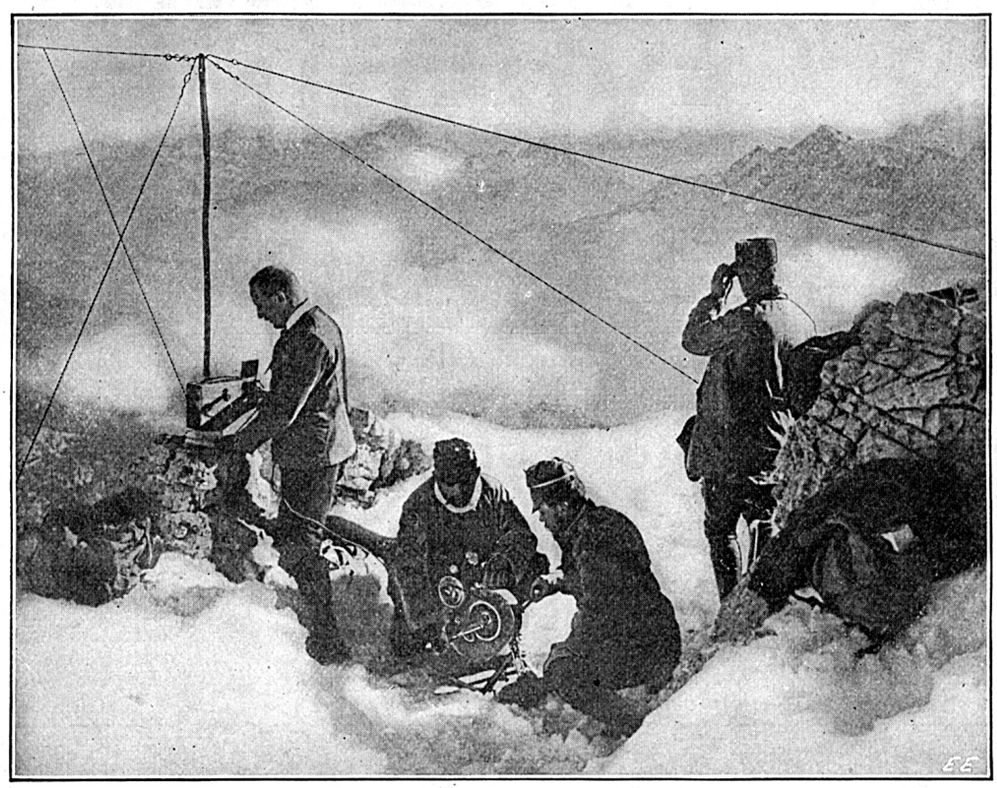
The speech was telegraphed in advance the day before the President spoke, to the Division of Foreign Press of the Committee of Public Information at New York City. The Government's private wire was

telephone. When it had been verified, it was cut into "cable takes" of approximately 100 words each, and the operators who were to handle it opened their keys and got ready for the "flash" which would tell them to start sending. The speech contained about 2,700 words. Every one who had anything to do with the handling of the speech was

To London it went by Western Union cable. There it was given to the Reuter, Exchange Telegraph and Central News agencies, which flashed it at once to all the newspapers they serve. Via Western Union cable the message flashed to London and was actually delivered in that city in 2 hours and 35 minutes. Reuter's agency in

AUSTRIANS USE RADIO IN ALPS.

The Radio operator in active military service does not always have a hut or dug-out in which to set up his instruments. The photo herewith illustrates a temporary Austrian radio station near the top of a mountain peak in the Alps. The small antenna mast is guyed in position as shown and the operator at the foot of the pole is busy receiving a message. At the extreme right an officer is making observations which he reports to the wireless man for transmission to headquarters. Note the two industrious radio squad men kneeling down in the center of the photo. They are the "dynamo men" and their duty is to turn the crank and spin the dynamo until the voltmeter registers 110 volts. The operator can then press his key and send out his message. No current is necessary for receiving the messages. Photo © by Underwood and Underwood



Far Up in the Cold Mountain-tops, Thousands of Feet Above Sea Level, the Wireless Proves Itself Invaluable. This Portable Radio Set Is Being Used by an Austrian Signal Corps Squad in the Alps Region.

PERISCOPE FOR READING TRANSFORMER TEMPERATURES.

In order to read the temperature of the oil as indicated by the thermometers on transformers, the Pacific Power & Light Co. in one of its sub-stations has attached periscopes to each transformer to enable the operator to observe the temperature from the floor. This makes it unnecessary to use step-ladders. The periscope consists of a square metal tube 4 ft. 8 in. (1.4 metre) long and 2 in. (5 cm.) square. At the ends are placed two mirrors facing each other at an angle of 45 deg. with the sides of the tube. The lower mirror is 1⅞ in. (4.8 cm.) wide and 3 in. (7.6 cm.) long, while the upper one is 1⅞ in. (4.8 cm.) by 3⅛ in. (8.6 cm.) long. The upper mirror is made longer to give a longer view of the thermometer scale.

ELECTRIC SHIP HAS FUTURE.

The electric ship is no longer a dream but a reality, and it is quite possible that within a few years of the close of the war every new vessel of any size will be driven, steered, stopt, reversed or turned, merely by the pressing of a series of buttons on the bridge. The application of this principle will enable ships to be run with the highest efficiency at an even speed, permit marine engineers more liberty of design and yield proportionately greater cargo space than the present cumbrous form of machinery allows. The newer American merchant ships are electrically controlled.

London also recabled it immediately to the American Ministers in The Hague, Stockholm, Copenhagen and Christiania, thus covering Holland, Sweden, Denmark and Norway. The Ministers gave out the speech as soon as they received it to all the news agencies in their respective countries.

From London the speech was sent also to Petrograd and distributed to the news agencies by a branch of the American Committee on Public Information in the Russian capital. From Petrograd it was telegraphed over land lines to Moscow and thence to Brest Litovsk, the scene of the recent Russian-German peace parley.

To Paris the President's address was sent by way of the Commercial Cable in the space of 1 hour and 38 minutes. There it was given out to the Havas News Agency, the Agencie Radio and the Maison de la Presse, the French official institution for distributing news. These organizations forwarded it to Berne, to Rome, to Athens and to Madrid and Lisbon; thus covering Switzerland, Italy, Greece, Spain and Portugal.

News wires are working between Berlin and the Holland border, as well as to the Swiss border, so the speech got into Germany certainly from one or another of these border stations, (the message received in Holland and Switzerland being transmitted to the German border by courier, from which point it was telegraphed to Berlin) and doubtless was sent down thru the Central Empires from Berlin.

South Africa and India receive their news thru the Reuter Agency in England, and the speech was cabled to them by that organization.

It was sent to Australia by the British cable which runs from Vancouver, B. C., to Sydney. It was telegraphed to San Francisco in the short time of 1 hour and 38 minutes, and then cabled to Hawaii, to Shanghai (there distributed by Reuter's) and to Tokio, where the Japanese agencies —Kokusai and Nippon Dempo—sent it out.

By cable the speech went by direct cable to Havana, Port au Prince, Hayti and Carraccas, Venezuela. It also went via direct cable to Colon, across the isthmus to Panama, and from there down the west coast of South America to Santiago, Chili, whence it was telegraphed across the Andes (over the longest *under-ground* cable in the world) to all the lower capitals of South American republics, reaching Buenos Ayres first.

From the naval radio station at Darien, on the Isthmus of Panama, the address was flashed out to all the little islands and ships in the Caribbean. The naval radio station at San Diego, Calif., also flashed the message to ships in the Pacific.

The United States and Canada, of course, received it thru the ordinary news agencies which supply both.

An idea of the speed with which the speech was sent out may be had from the fact that Buenos Ayres reported back that it had been received in full one hour and forty-five minutes after the operators here had stopt sending. Meanwhile it had been retelegraphed across the mountains down in South America.

Many extremely interesting points were revealed by this gigantic news propaganda which the average person, who never uses the cables, knows but little about. In the first place the modern atlas and geography "map of the world" does not show anywhere near all of the cables now laid and in successful operation in various parts of the world.

Several interesting long-distance cable routes used in broad-casting the President's speech of 2,700 words to the world are the following, and which were not mentioned in the newspaper accounts. In the preparation of this article the editors have had the assistance of Mr. Donald McNicol, Assistant Electrical Engineer of the Postal Telegraph Co., and Mr. Walter S. Rogers, Director of Foreign Press Division at New York.

The speech reached the "Far East"—India, Sumatra, Java, Ceylon (of Lipton tea fame) and the Malay Peninsula by cable. The message sped over the ocean cables from Lisbon, Portugal, down along the west coast of Africa, via Cape Verde Island, to Cape Town, South Africa. From here it was telegraphed across country to Durban, on the east coast, and flashed on via Mozambique north to Aden, at the south end of the Red Sea, thence by cable to Bombay, India. It continued from here by overland telegraph to Madras, on the east coast and, once more speeding under water, reached Penang on the Malay Peninsula. From Penang the message spread to the several islands in the East Indies. An alternative cable route, but liable to interruption due to present naval activities in the Mediterranean Sea, lies along the coast of Portugal from Lisbon, via Gibraltar, thru the Mediterranean, thence along the Suez Canal route, thru the Red Sea cables, to Aden

(*Continued on page* 802)

BACK NUMBERS!—Many readers desire to obtain back numbers of this journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of The Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each over one year old, 35 cents each.

Can Electricity Destroy Gravitation?

IS it possible to nullify, and further to even reverse, the effect of gravity by electricity? This scientific conundrum seems about to be solved, at least to a certain extent. To begin with, everybody is familiar with that law of physics which states "that all particles of matter attract each other with a force which is greater the nearer the particles are together," and to be still more definite, Newton's law says that bodies behave as if every particle of matter attracted every other particle with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. It is the gravitational attraction between the earth and the bodies upon it which causes the latter to have *weight.*

This fact is often lost sight of and should be well understood by every student. To make the matter more clear let us imagine that a man's body is (as by flying, jumping, diving from a high point, etc.,) for the moment separated from the surface of the earth. As soon as the mass of the body is separated from the earth, gravitational attraction is set up between the two masses. The earth pulls the man's body, and also his body pulls the earth, but as the mass of the earth is infinitely greater, its movement cannot be detected.

The scientists of to-day believe that in some mysterious way the minute electrical charges existing on the particles making up molecules and atoms are definitely linked up and concerned with such basic phenomena as *gravitation.* Since all bodies are made up of atoms it would seem to logically follow that the forces of gravity must depend in some way upon attractions which atoms exert upon each other, and due to the fact that the atoms are separated, at least in solids and liquids, by extremely small distances, we might expect these interatomic forces to be relatively more powerful than are those of ordinary gravitation. Until recently, however, the mystery linking this inter-atomic activity with the force of gravitation baffled all attempts at solution, altho many scientists had tackled it.

But at last experimental proof has been forthcoming thru the untiring labors of Professor Francis E. Nipher, of the St. Louis Academy of Science. In a pamphlet issued November 8th, 1917, Professor Nipher supplies experimental evidence that gravitational attraction can not only be suspended or nullified by the electrical current, but it actually can be transformed into "gravitational repulsion!"

All during the summer of 1917, Professor Nipher had his apparatus in almost

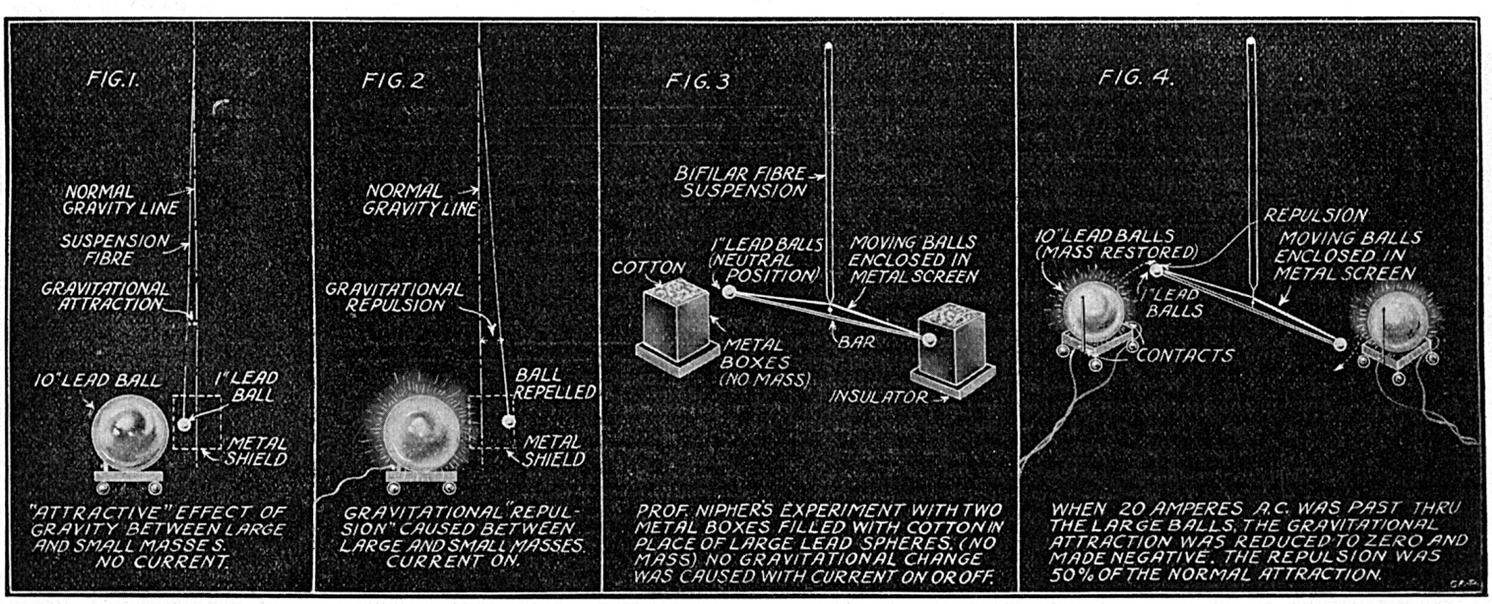
Prof. Francis E. Nipher, of the St. Louis Academy of Science, Who Has Proved By Laboratory Experiments That Gravitation Can Be Nullified and Even Converted Into Repulsion, By Electric Currents Properly Applied.

continuous operation and the experiments have been repeated time and again, always with the same result.

Prof. Nipher's mechanical apparatus resembled that used in the "Cavendish experiment," by which it was first experimentally proved that Newton's law of universal gravitational attraction applied to small bodies in their action upon each other at short distances, just as well as it did to small terrestrial bodies under the influence of the earth. This apparatus consists of a delicate torsion suspension fiber (see Figs. 3 and 4) a light, rigid arm at the lower end of the fiber suspension, and at either end of this bar two small lead spheres of known mass. Two equal large balls of solid lead are placed close to the small suspended spheres in the manner shown. Now, remembering our law of physics stated above—that every body in space attracts every other body proportionally to their respective masses and inversely as the distance between them—then it is evident that when this apparatus is set up, that the small suspended spheres will be slightly attracted by the larger, stationary balls. This condition is represented in Fig. 1.

Before connecting any form of electric current to the modified Cavendish apparatus, Prof. Nipher took special precaution to carefully screen the moving element from any electro-static or electro-magnetic effects. His apparatus briefly consists of two large lead spheres ten inches in diameter, resting upon heavy sheets of hard rubber. Two small lead balls, each one inch in diameter were now suspended from two silk threads, stationed at the sides of the two large lead spheres, from which they were separated a little distance. Moreover, the suspended balls were insulated elaborately from the large spheres by enclosing them first airtight in a long wooden box, which was also covered with tinned iron sheets as well as cardboard sheets. There was, furtheremore, a metal shield between the box and the large metal spheres. The large metal lead spheres now exerted a certain gravitational pull upon the suspended small lead balls as indicated in Fig. 1, and the small lead balls were slightly pulled over towards the large spheres.

In his first experiments Prof. Nipher applied a high tension current from a static machine to the large lead balls, see Fig. 2. No difference was noted whether the positive or negative terminals were applied. In one of these experiments the masses were "repelled" (normal gravitational *attraction* had been nullified and changed to *repulsion*) by a force nearly *twice* as great as the initial gravitational repulsion. This effect is shown at Fig. 2.



Several Simple Diagrams Which Show, in a Manner Understandable to All, the Essence of the Epoch-making Experiments on the Effect of Electricity on Gravitation, as Conducted by Prof. Nipher at Washington University, St. Louis, Mo.

In further experiments Prof. Nipher decided to check his results. To do this he replaced the large solid lead spheres with two metal boxes, each filled with loose cotton batting. These hollow boxes

(*Continued on page* 803)

Electricity and War in the Films

THRILLS, thrills and still more thrills! seems to be the slogan behind the majority of motion pictures on the screens in these tempestuous times. Surprising it is indeed the extent to which producers will go to secure the "reel" hair raisers, and in nearly every instance Science plays the all important rôle.

In the wonderful advance made by the photoplay in the last few years, the small and intricate details have come to receive more and more attention. The critical public has learned much in recent years; therefore it would not do to make use of scientific apparatus nowadays without some regard for its correct appearance and application. Foremost amongst the new films may be mentioned Thos. H. Ince's latest production "The Zeppelin's Last Raid." Mr. Ince has had a phenomenal rise in the motion picture field and must be complimented on this splendid and timely picture. A word would not be amiss regarding the work he has done to advance the motion picture along the path of big things. Five years ago he was next to being down and out, but he had an idea and struggled along till the chance came to produce on a big scale, his foremost and initial photoplay sensation being "Civilization," which cost thousands of dollars and employed hundreds of people to produce. "The Zeppelin's Last Raid" shows vividly the danger that the United States is exposed to, and to save us if possible from the lesson that was so bitterly learned by Belgium, France and England.

The story is woven around Mr. Hickman, the commander of a Zeppelin, and Miss Markey, a young and pretty girl who, with hundreds of others, is secretly working in an effort to rouse the populace against Kaiserism. The commander, like many other officers in the army and navy, is also a member of the same organization. The attack of the Zeppelin upon the defenseless British hamlets is one of the most strikingly realistic scenes ever converted to the screen. The biggest thrill comes when the commander of the "Zep" dynamites it, at the moment the crew attacks him for refusing to hurl bombs upon the defenseless city below. And the nerve-stirring scene of the flaming dirigible rushing downward to destruction is one not easily forgotten. The "Zep" is complete in every detail and in one of the photos herewith may be seen the releasing of the powerful death-dealing bombs. The orders are given to the men from the main observation post by telephone. Another scene shows the up-to-date radio equipment on board the Zeppelin.

The mammoth Marconi wireless station located just outside Los Angeles, Cal., recently taken over by the U. S. Government, was made use of in filming some of the important scenes.

The third photo shown is taken from a later episode of the gripping film drama—"A Daughter of Uncle Sam," showing the inner workings of the German spy system in this country. The action abounds in many stirring scenes and the one illustrated shows two German plotters secretly operating a concealed Radio station in the woods.

Above—Two Teuton Plotters Operating a Spy Radio Set in the Woods in "A Daughter of Uncle Sam."

Left—Preparing Zeppelin Bombs for Action by Means of Magnet in "The Zeppelin's Last Raid."

Right—Another Scene on the "Zep," Showing the Radio Instruments and the Operator.

HUN RADIO AT NIGHT DARES U. S. TO STRIKE.

Commanders and crews of the American destroyers operating in European waters are talking about a grim piece of Hun humor. Nearly every night the commander of one of the destroyers receives by wireless a message reading:

"My position is (so many) degrees north and (so many) degrees west. Come and get me. I'm waiting for you." The message is always signed, "Hans Rose."

Rose is the German who took a submarine into Newport two years ago. According to the story past around by the men engaged in the thrilling and hazardous task of seeking submarines, the captain to whom is directed the nightly messages of the German sub-sea craft, sank two. The commanders of both were intimate friends of Rose. He has sworn vengeance.

It is disquieting for the American commander, but he has no fears. Twice, it is stated, he has swiftly guided his craft to the location described by his enemy, but has found nothing. Still the mysterious wireless dispatch comes every night, no matter where the destroyer may be. Others catch it, and thus the weird story is told whereever the hornets of the sea are seen.

THE TELEPHONE MOUTHPIECE—HOW TO USE IT.

Science and experience have combined to determine the shape and size and material to be used in the proper construction of the most efficient mouthpiece.

This part of the telephone is designed to gather the sound waves of the voice, and will do so more efficiently when the lips of the person speaking are about half an inch from, and directly in front of it.

It is designed exactly for the purpose of most efficiency by accommodating the sounds from close proximity and excluding the distant sounds which would interfere with the transmission. Did you ever stop to consider how you hear only the speaker and not the other sounds of the room in which the speaker is?

When speech is directed to the mouthpiece at an angle, or from a distance of from six inches to a foot away, the person at the other end of the line cannot hear your voice distinctly.

The best results will be obtained by speaking directly into, and close up to, the mouthpiece in a clear, not-too-loud tone of voice.

WIRELESS FOR ST. PETER'S IN ROME.

The establishment of a wireless station on the dome of St. Peter's in Rome has been suggested to the vatican so that it may secure independent transmission of foreign messages of diplomatic character in code and also receive confidential and reliable reports from the vatican's representatives abroad. The question of speed is involved since at present wire transmission from France and England consumes 24 hours while much longer is required to receive messages and news from the United States.

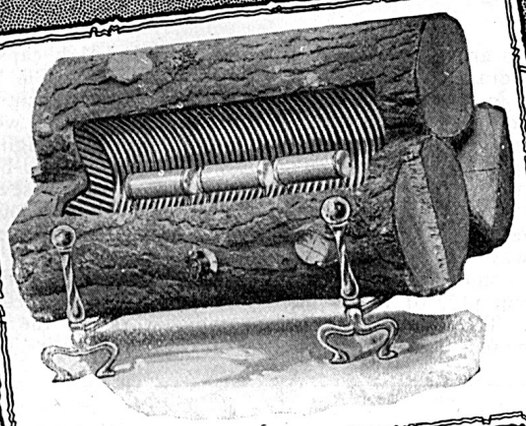
It is pointed out that the wireless would have the advantage of dealing with Switzerland, Austria, Germany and Russia. The vatican never has been able to rely upon newspaper reports for quick news.

The Italian Government is not likely to raise decided objections because the vatican never has paid tolls on its messages.

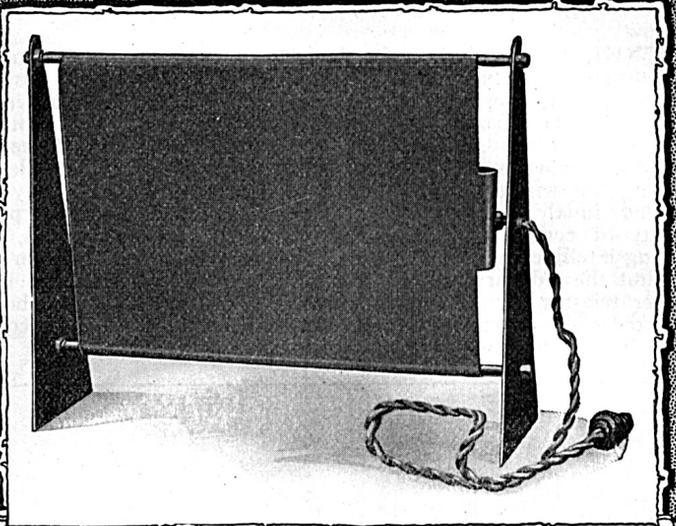
ELECTRIC LIGHT TO MARK AERIAL ROUTES.

Electrical companies and town councils in the United States are offering to provide the "lighthouses" necessary to mark the aerial routes between Dayton, Ohio, and Indianapolis, Ind., and other cities to be used by the aviation corps of the United States Army in training students for this service.

"ELECTRIC WINTER-TIME COMFORTS"

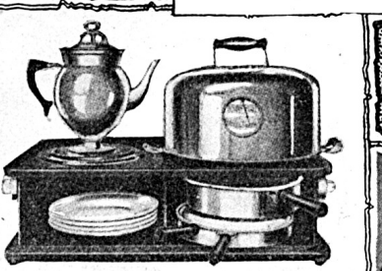


The "Electric Log" Will Keep You Warm, Besides Giving a Cheerful Fireside Glow, Just Like Grand-dad's Open Fire-place.



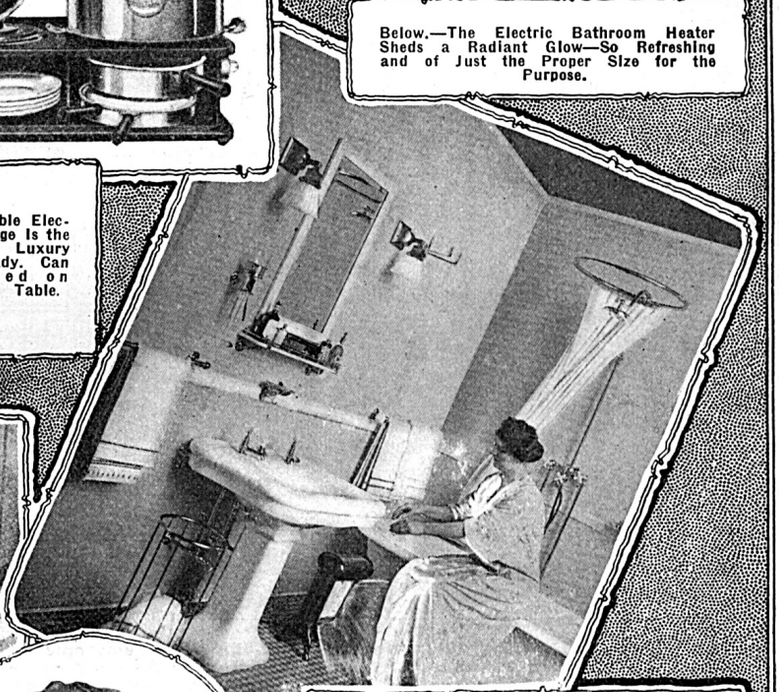
For Warming Bedrooms and Other Small Apartments, the Flat Sheet Heater Stove Here Shown Proves Extremely Handy and Efficient. Built In 600 to 4,000 Watt Sizes.

While "Pop" Lights His Cigar from an Electric Lighter, Sonny "pops" the Corn in His Electric Corn Popper.

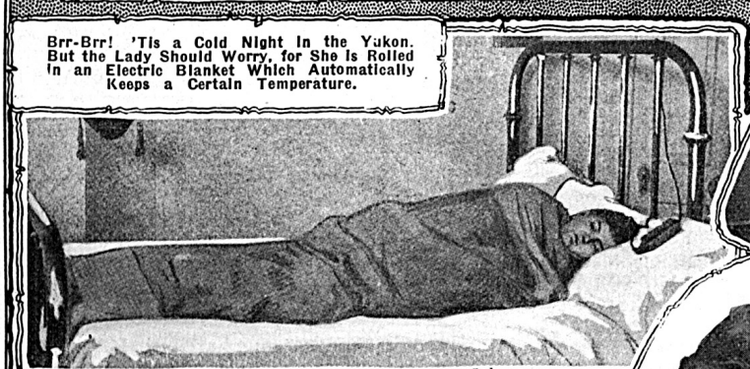


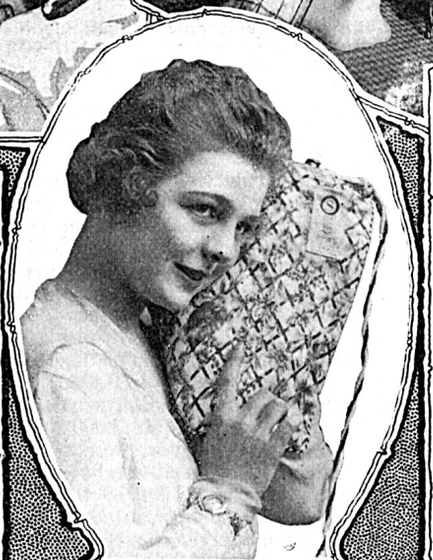
A Portable Electric Range Is the Latest Luxury for Milady. Can be Used on Dining Table.

Below.—The Electric Bathroom Heater Sheds a Radiant Glow—So Refreshing and of Just the Proper Size for the Purpose.

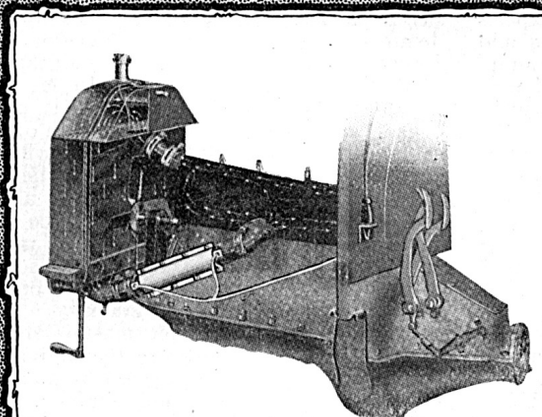


Brr-Brr! 'Tis a Cold Night In the Yukon. But the Lady Should Worry, for She Is Rolled In an Electric Blanket Which Automatically Keeps a Certain Temperature.

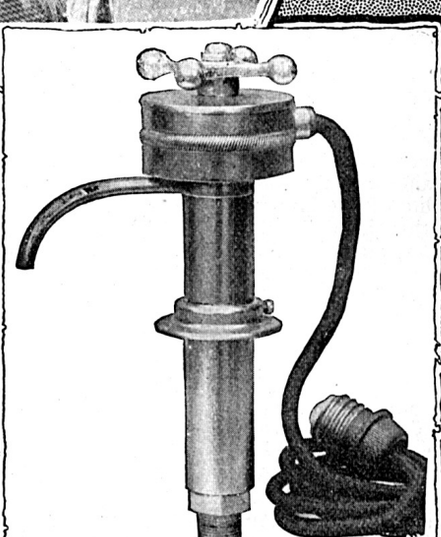




Oh! Clarice! We Didn't Know You Had a Faceache—But Rest Assured, This Electric Warming Pad Will Alleviate Your Suffering in a Short Time. Connects With Any Lamp Socket.



New Electric Heater for Use on Auto Engines. It Plugs Into Any Lamp Socket and Makes Starting the Engine a Sure Thing In the Winter.



Something New in Hot Water Devices—the "Electric Spigot." Heats the Water Instantly and Attaches to Any Water Pipe.

How U-Boats Send Radio 1,000 Miles

By H. WINFIELD SECOR

THE Germans have developed submarine radio-communication to a fine art—they had to. This is so for obvious reasons—chief among which is that the success of the U-boat campaign depends to a large extent on keeping in wireless communication with the individual sub-sea boats and the possibility of certain of their number transmitting intelligence to the nearest land base. At first the submarines made use of folding or telescopic masts which did not elevate the radio antenna very far above the deck—not more than 20 to 30 feet in most cases. For ordinary inter-communication between submarines this collapsible antenna served its purpose admirably. Where long ranges were to be negotiated, either in receiving or transmitting, however, it became a real problem.

One of the latest Teutonic improvements in this arm of the naval service is the utilization of balloons for elevating the U-boats' antenna wire to a height of 1,000 feet and more. In this way vast distances can be covered and valuable intelligence sent by radio to a second relay submarine if necessary, so that it is not improbable that the news of ships' sailings from American ports could have been radioed to Germany by the aid of three or four U-boats.

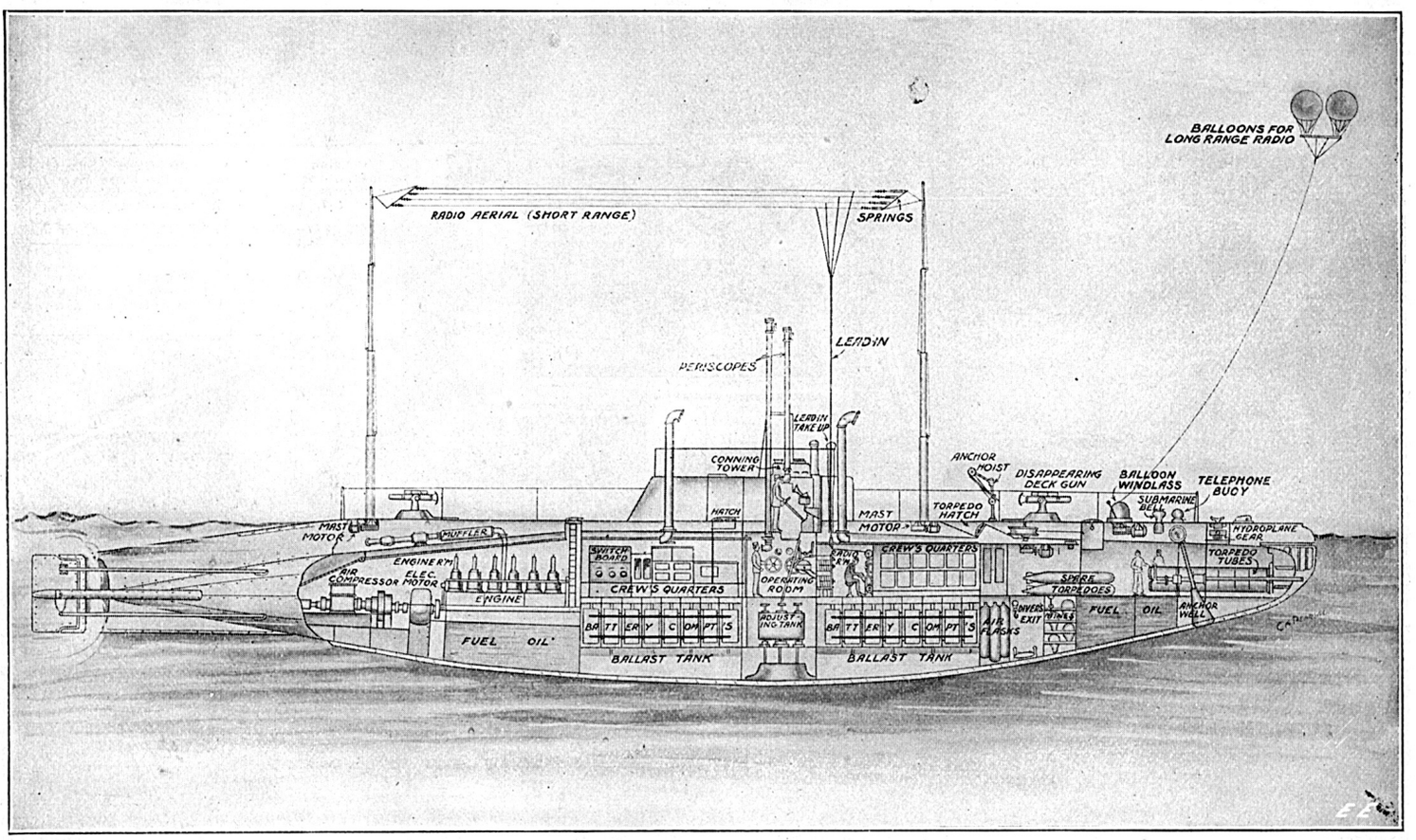
Our front cover illustration, as well as the ones herewith, show clearly just how the balloons, two in number and fastened to a rigid equilibrium member, carry up the antenna wire to a height of several thousand feet if necessary. The antenna, at its base, is wound on a special electric-motor driven drum. This drum is instantly controlled by the throw of a switch, so that if a ship comes into view, it can rapidly reel in the balloon antenna and the balloons are taken inside, hatches closed, and the craft submerged—all in almost less time than it takes to tell about it. It is difficult for an enemy ship to see the balloons as they are cleverly camouflaged, being painted partly white and partly blue, so that against the sky they are practically invisible. The antenna wire is, of course, quite fine and invisible at even a short distance away.

It has been a mooted question for some time as to just how far such a radio-equipt sub-sea fighter could send a message. The receiving range with such a balloon suspended aerial is easily several thousand miles, using modern amplifiers and other refinements in the radio art. The writer asked several well-known radio experts their opinion on the possible sending and receiving activity of a balloon-aerial equipt U-boat and they practically all agreed with the ideas exprest by Mr. F. H. Kroger, chief engineer of one of the leading American radio companies, that; with fair weather conditions, and with the proper radio transmitting apparatus tuned to a high wave length, it would be possible for the submarine to send a wireless message 2,000 miles, and possibly 3,000 to 4,000 miles under extremely favorable conditions. The transmitting set used might, of course, be a special one rated at 15 to 25 kilowatts. If the sub-sea boat wanted to transmit an important message, she would in all likelihood choose the night-time. She could then emerge and fly her balloon aerial with reasonable safety. And for a long range message requiring as much energy as mentioned above, it should be remembered that there is available all the engine power required. All that would have to be done would be to connect up the high capacity dynamo to these engines, and this in turn to the special high power radio transmitter. Such a set, including the dynamo, would not occupy such a large space as might be imagined off-hand. Also the newer U-boats are veritable submarine-cruisers, several hundred feet in length, which, of course, gives a much greater space for the radio equipment.

Many ingenious folding and other types of masts have been perfected for medium and short range radio work on the submarine. Several of these masts are illustrated in the drawing herewith. An interesting practical telescopic mast was patented by a Yankee inventor several years ago (U. S. patent No. 1,099,861) and is shown in detail at Figs. 1 and 2. The inventor, Mr. Joseph Raes, covered several modifications of the basic idea in his patent. In one type a continuous flexible metal cable is used, Figs. C and D. By following the path of the cable in the drawing it is seen how, when a pull, as produced by a motor, is applied to the lower end of the cable, it causes all of the sliding telescopic members to be elevated. The upper end of the cable is secured to the bottom of the top telescopic member. When pressure is removed on the cable the mast descends by gravity.

A similar type telescopic mast is shown at Fig. B, only in this case the individual sections are raised and lowered by a clever arrangement of gears and shafts. This elevating scheme would be considerably slower than the previous cable-operated type.

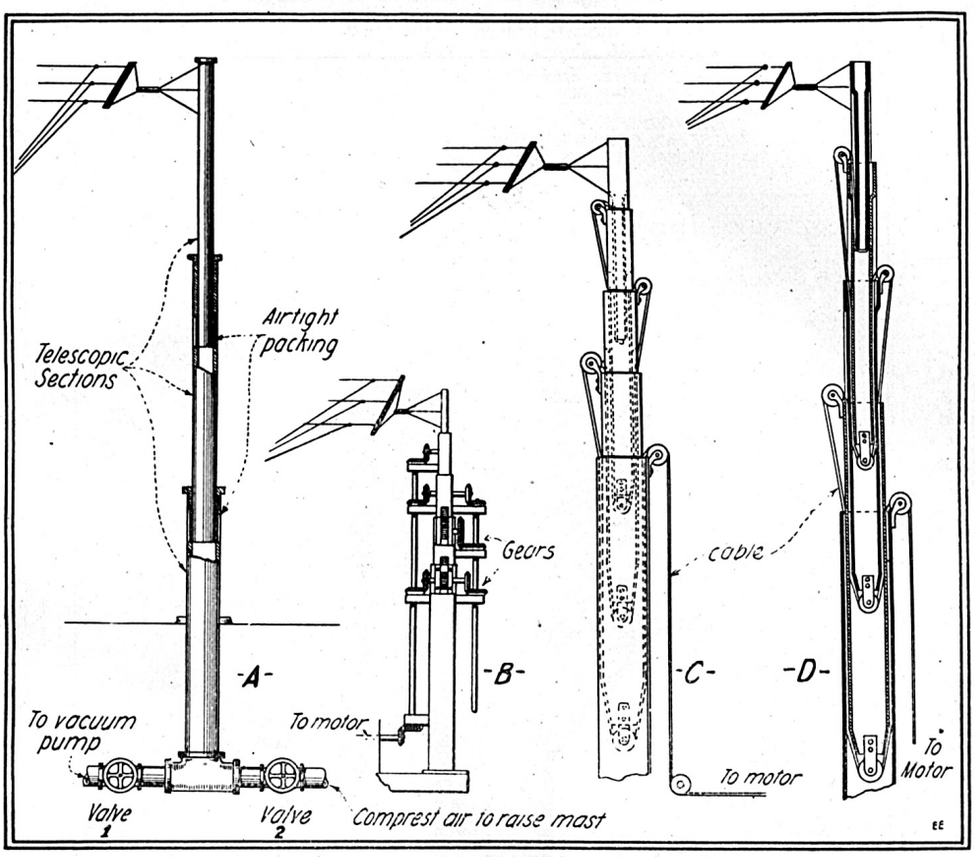
The author suggests herewith a pneumatic telescopic radio mast of the type illustrated at Fig. A. This is similar in principle to the pneumatic (comprest air) lifting



Sectional View of Modern Submarine Showing the New Telescopic Collapsible Masts Supporting the Radio Antenna, as Well as Motor Actuated Cable Windlass for Rapidly Reeling in Balloon Aerial Wire. The U-boats Are Said to Be Using the Balloon Aerial for Communicating by Radio Over Distances of Several Thousand Miles.

cranes used in manufacturing plants, foundries, etc. With the proper pressure of comprest air, it is only necessary to close the suction blower pipe valve, open the high pressure air valve attached to the pipe line from comprest air tank or flasks, and the mast rises up by expansion of the air within it. When it is desired to lower the mast quickly, the comprest air valve is closed and the suction blower line valve slowly opened; the air is thus removed and the mast collapsed. Ordinarily, no suction would be required to lower the mast; merely a valve opening to the atmosphere thru which the comprest air could rush to the outer air.

An ingenious collapsible radio mast was invented in Germany some years ago and several of them have been used in this country. It was perhaps the lightest ever designed thus far—possibly too light for submarine requirements — but it possest the element of speed. It employed four flexible strips of metal rolled on drums at the base. These strips were notched on both edges and when the handle was turned, the four notched strips of thin steel intermeshed with each other, making a lock-cornered square tubular mast about 8 inches square. It was found possible to raise a platform containing two men on it to a height of 80 feet for observation purposes when necessary. Two men could raise the mast in a short time by turning a geared crank handle.



Some Examples of Collapsible Radio Masts Adaptable For Use on Submarines. The Types Shown Include the Comprest Air, Steel Cable and Gear Actuated Telescopic Forms. A Motor Operates the Gear and Cable Types Directly.

The accompanying illustration of a modern submarine shows how the various compartments are arranged. It was prepared from official plans of such a craft. The location of the collapsible radio masts is given, as well as the position of the motor-driven winch for hauling in the antenna balloons. An interesting feature not generally known is that submarines are now fitted with submarine telegraph apparatus which operates by means of sound waves sent thru the water from powerful electric vibrators mounted on the hull of the submarine. Sensitive microphones suitably mounted on either side of the hull enable the commander to tell when a ship is approaching, even at a considerable distance, by the sound of her propellers which is transmitted thru the water.

Then there is the latest safety feature—the *telephone buoy*. If the submarine should sink and become unmanageable, the crew can pull a lever which releases the telephone buoy, which rises to the surface of the water. Any craft passing in the vicinity of the sunken sub-sea boat can open this buoy and, by means of the telephone inside it, speak to the imprisoned crew. Submarines send out sound signals of distress thru the water also, which may be intercepted by another submarine or by a warship or steamer.

A WAR-TIME SUGGESTION TO RADIO AMATEURS.

By Howard S. Pyle,
Electrician-Radio, U. S. N.

FELLOWS, in writing this, I want to address it to the Amateurs—the real, dyed-in-the-wool "hams," who have started in the right way—a spark coil of uncertain antecedent, a few discarded dry cells from the family Ford, a lump of silicon—you know the type. Fellows that started with gigantic problems to face, no one to help and who have "stuck to it."

We have today, altho at present closed by our Government, such an efficient chain of amateur stations in this great country of ours, that, were it forecasted ten years ago, would have brought derision down upon one who would be so bold as to suggest it. And if you will look up the "star" stations, you will find that they are practically all in the hands of fellows that ten—yes, even five years ago—were struggling thru many failures, working out their own problems, 'nary a beacon to guide them in the right way. Look where they stand today—foremost among the country's youthful scientists and possest of an enviable knowledge of that most fascinating of mysteries—WIRELESS!

I have watched and grown up with them for the past eight years myself so am basing this on facts. While my stations never hung up any extraordinary records for transmission, due to several handicaps from outside sources which it was impossible for me to overcome, yet my interest has been just as keen thru all the years and I hailed each new record with as much delight as if it were my own. I did have sensitive receiving apparatus, however, which I kept strictly up-to-date and have spent many, many pleasant evenings (and wee hours) with the "cans" on and am proud to consider myself one of the "self-mades."

To come to the subject of this article, tho, we amateurs have built up our present organization upon our own lines. As our problems were presented we worked and finally overcame them. They were our problems—we fought them as such. Meanwhile the commercial companies met their barriers also and overcame them. Now doesn't it seem reasonable that the commercial companies, having to build their organization to the highest stage of development, as theirs is a cold, commercial proposition, many people being dependent for their living upon the success of wireless as a commercial enterprise — doesn't it seem reasonable to you fellows to grant that these companies have a higher, more efficient service than the amateurs? Of course they have, as they must have to remain in business.

Supposing a commercial telegraph company accepted a message from Portland, Oregon, to Los Angeles, Calif., would they deliver it at its destination, a week or so after the filing? Would a company send a message from Seattle to Portland, Oregon, and effect the transmission in a few minutes but hang the message up at its destination and deliver it four days later? How long would they remain in business if they did? Yet these are both actual amateur examples of occurences on this coast in one week! In the former case: no excuse as a line of communication is available (or was at that time) between those two points at all times, with numerous relays if necessary. In the latter case: also inexcusable as direct 'phone connection between the receiving operator and the addressee was to be had. The latter finally heard of the message in a roundabout way and after some trouble and inconvenience, finally got it.

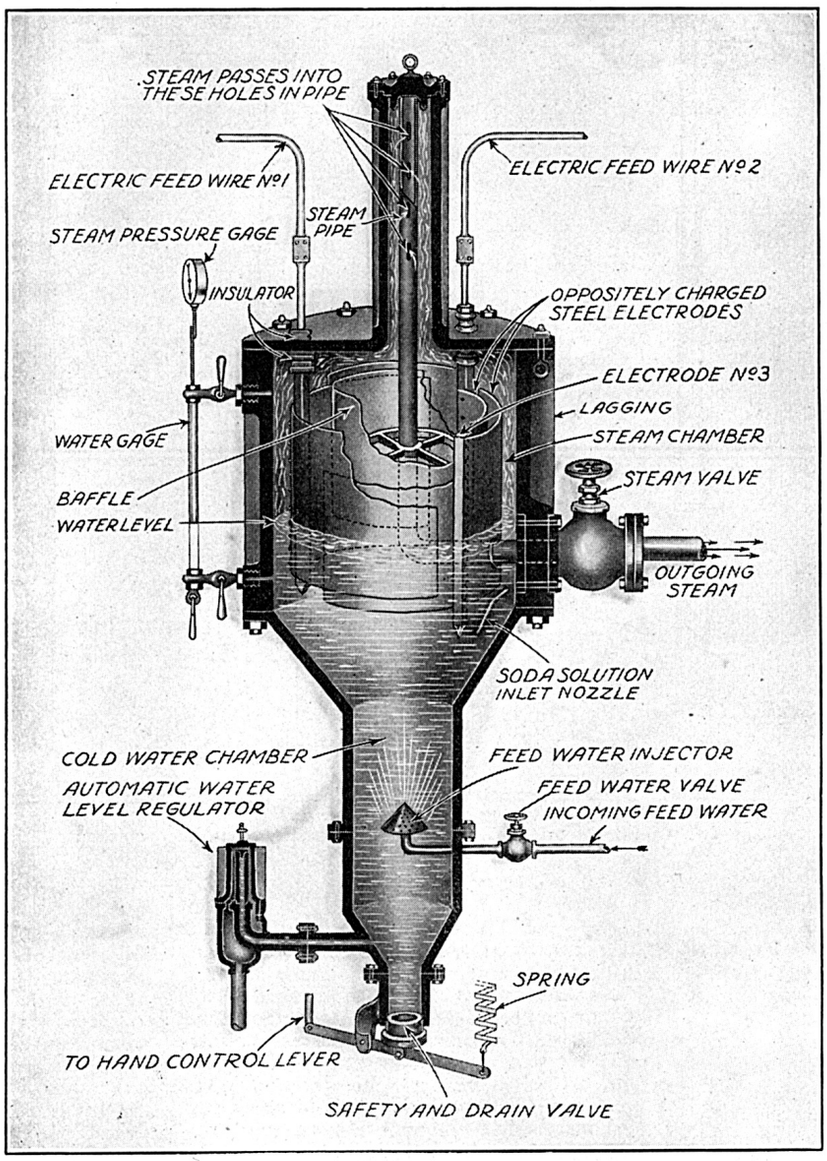
Altho I'm in the commercial game now, yet I'm a "ham" at heart always, and want to see them make a name. I keep in close touch with the fellows, altho I'm "all over the ocean" at times, so to speak. It's only since breaking into the commercial game that I saw the faults of our organization and I would suggest that our best "hams" spend a little time in commercial service—even only a few trips on some vessel. Operators are scarce and jobs plentiful and I'll warrant you'll have your eyes opened and it will result in better service in the future among our own stations. Think it over, fellows. If you don't feel like joining the U. S. Navy, why not try the U. S. Naval Reserve Force. They are looking for good radio operators every day. Come on, fellow "Radio-bugs"—put on your hat and take a walk to the nearest recruiting office—and don't forget the great chances looming up now for a berth as radio officer on the vast merchant marine fleet Uncle Sam is building. Look into this—it will pay you.

Electric Steam Boiler Most Efficient

JUST one year ago, in the March, 1917, issue of this journal, we had the pleasure of describing and illustrating a remarkable piece of engineering work carried out successfully by Italian engineers, viz., the application of volcanic heat to a steam boiler and thence to a dynamo, from which several thousand horsepower were distributed at high potential to a considerable area in northern Italy. Now, we are confronted by another ingenious and successful steam-electric stunt, due to an Italian engineer—Colonel Revel of the Italian army, whose extremely simple electric-steam generator is described in *Engineering* of London. As we do not know just yet how to produce electricity direct from coal or other combustive or explosive fuel, we shall not find, possibly, a very extensive field for Colonel Revel's new electric-Steam boiler, as it uses electric current to convert water into steam. But where there is superfluous hydro-electric power available, there we should find the Revel electric boiler of great economic value. Especially when it is considered that *steam is produced by the passage of the electric current thru water* at the almost unbelievable efficiency of 98 per cent. That is, 98 per cent of the energy in the electric current sent thru the water is actually converted into steam. The efficiency of the average coal-fired boiler is only about 50 to 60 per cent.

The principal characteristic feature of the generator is that for the transformation of electric energy into heat, and thereafter into steam, use is made of the ohmic resistance of the water which has to be evaporated. The Revel apparatus can be inserted in any alternating-current circuit of from 200 volts to 3,600 volts, and these are the form of current and pressures which are usually supplied for industrial purposes. In the Revel system, moreover, the production of steam is regulated automatically and continuously as required; the apparatus is entirely automatic in its action and demands no attention. Lack of feed water would only result in a decrease or a stoppage in the production of steam until the feed water difficulty was overcome. A 97 per cent to 98 per cent efficiency is claimed for this type of machine, since the whole of the heat generated by the electric energy is absorbed by the water, the only loss being that caused by radiation from the body of the apparatus.

The Revel generators are constructed to work at any pressure up to 14 atmospheres, and can be connected up at any time with the steam pipes from the ordinary steam boilers; owing to the rapidity of their action they take up any excess of *hydro-electric* (i.e., water-power electric energy) energy which may be available even for a short time. They may, in fact, be considered as serviceable appliances for turning to account any superfluous hydro-electric power available, and as such they were utilized in numerous installations in Italy before the war, when the price of coal did not exceed $8.00 per ton. At the present time they are also found to be practical and economical, even in cases where hydro-electrical power has to be paid for at the rates now ruling. The Revel electric boiler has been in successful use now for some time in many Italian works.



This Illustrates Graphically Just How the Revel "Electric Boiler" Generates Steam by the Passage of an Electric Current Thru the Water Between the Circular Metal Plates. The Resistance of the Water to the Passage of the Current Causes Steam to Form.

The semi-sectional view of the new Revel electric-steam generator here shown will aid in understanding just how this simple yet wonderful device operates. The working drawing shows one of these apparatus taking current at a pressure of 500 volts, in which we find the following arrangement: At the center, as shown, there is an electrode and steam space; at the bottom a cold water space. Thru the steam dome cover run three brass rods electrically insulated from the cover. In the steam and electrode chamber there are three sets of circular steel electrodes separated a short distance and rigidly fixt to the rods shown. Next we find a vertical steam pipe and steam pipe support and baffle; a feed-water injector, a steam valve, a water gage, a pressure gage, a receiver for soda solution, a water-level regulator, which automatically governs the working of the apparatus, a safety and drain valve, a handle for working this valve by hand and a feed-water valve.

The high-tension type has the same component parts as the low-tension type, and differs from the latter only in the shape of the electrodes and the dimensions of the steam dome, which in the high-tension type has the same diameter as the steam space.

One of these high tension installations in actual use in Italy consists of eight apparatus, taking three-phase current at 6,000 volts, each apparatus being capable of generating 900 kg. to 1,000 kg. of steam per hour.

In the Revel generator the transformation of electrical energy into heat takes place in the body of the water contained in the steam and electrode chamber, the water acting as an ohmic resistance inserted between the electrodes; the production of steam therefore varies with the immersed surface of the electrodes, and assumes all values between zero and the maximum, corresponding with the various levels of the water in the steam chamber.

For starting the generator the circuit-breaker is closed, the feed-water valve is opened, and a small quantity of soda solution is introduced from the small receiver to give a suitable conductivity to the water. When the water has reached the height of the lower edge of the electrode segments the current flows thru the water and commences to raise steam, the steam production increasing as the water-level rises, until it reaches the working pressure required. At this moment the automatic regulator enters into action, and the water-level, and hence the steam production, remain constant.

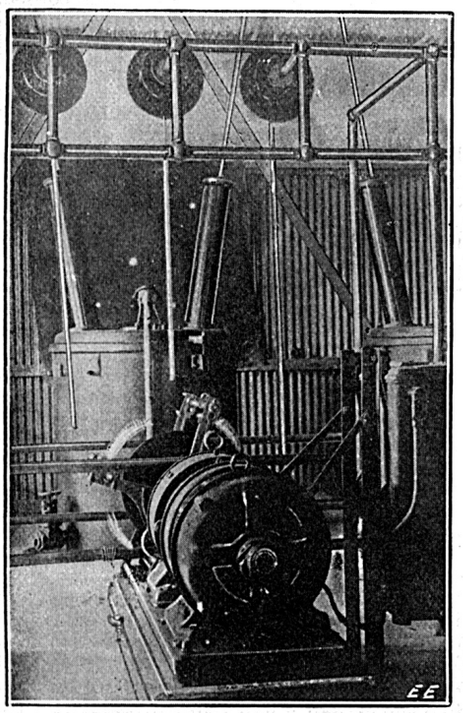
In order to stop the apparatus the feed-water valve is closed, the steam valve is closed slowly, and the bottom drain valve is opened by acting upon the hand lever until the ammeter has returned to zero.

When the feed water leaves a calcareous deposit it is advisable, every five or six hours, to free the boiler of the sediment deposited at the bottom of the truncated cone. This is obtained, without interrupting the working of the machine, by increasing the water feed and by acting at the same time on the drain valve handle, the excess water washing away the sediment; this operation, by a suitable action upon the feed water and drain valve and by following closely the ammeter and maintaining the current intensity constant, is carried out without changing the water-level and without impairing the working of the apparatus. The apparatus may find adoption in this country.

Eliminating the Smoke Nuisance by Electricity

By WILLIAM H. EASTON
Westinghouse Electric & Mfg. Co.

AS every reader of THE ELECTRICAL EXPERIMENTER knows, if a rubber comb is rubbed against a woolen cloth, it becomes electrified and is able to attract particles of paper, threads, and other small objects. This peculiar phenomenon was known to man long before the dawn of history, for electricity gets its name from the Greek word "electron," meaning amber, which, of course, acts just like rubber. It is our nature to endeavor to put into practical use everything we know, and it is therefore very remarkable that for at least 3,000 years no commercial application, outside of a number of interesting laboratory experiments, was made of *electrostatic attraction.*



New Electric Smoke-eliminator Outfit, Showing Motor-generator Direct-connected to Rectifier. 100,000-Volt Transformer in the Background.

Today, however, this principle is being extensively used to solve one of our most perplexing industrial problems—the suppression of smoke and dust. The smoke from chimneys, the dust from cement mills, blast furnaces, etc., and the acid fumes from chemical plants are not only intolerable nuisances, but also the visible evidences of a great waste of valuable material. Many attempts have been made to check these emissions but the Cottrell electrostatic process, (so-called after its inventor) appears to be the most successful.

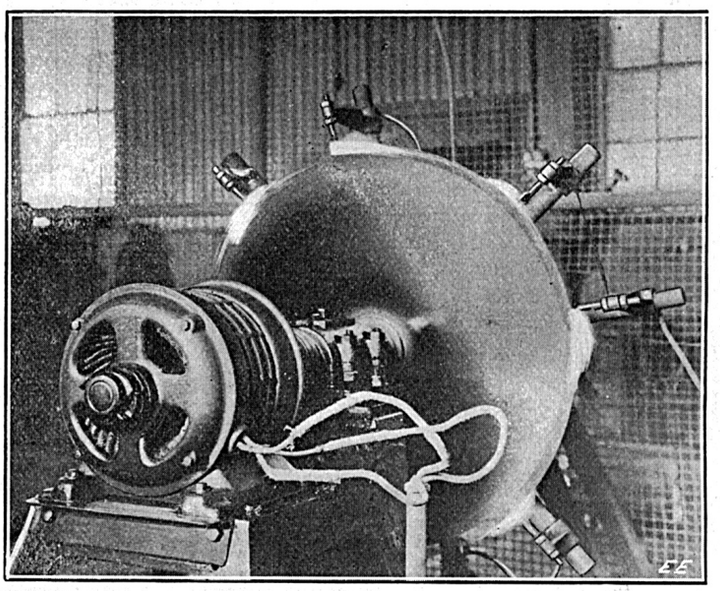
In this process the gases containing the solid particles of soot or dust, or the liquid particles of acid, are past thru vertical tubes or pipes in the centers of which fine wires or chains are suspended. The central conductors are connected with a source of *direct current* of from 40,000 to 100,000 volts potential and the pipes are grounded. The floating particles in the gases passing thru the tubes become electrified and are attracted to the walls of the tubes to which they adhere. At intervals the current is turned off, the tubes jarred or hammered by a motor-driven device, and the accumulated dust then falls into suitable hoppers below. When all conditions, such as the length and diameter of the tubes, the speed, temperature, and consistency of the gases, and the voltage of the current, are properly adjusted, an almost complete recovery of the suspended solid or liquid matter, can be secured. It is, however, impossible to remove gaseous particles in this manner.

It is, of course, impracticable to generate directly the necessary high voltage direct current. Alternating current is, therefore, stept up to the desired voltage by means of special transformers and this high voltage alternating current is then changed into direct current of equal voltage by means of a *rectifier,* which is simply a large revolving commutator.

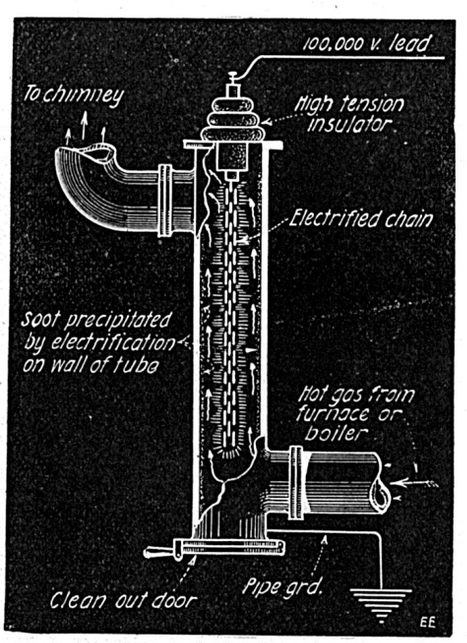
The alternating current can be taken from the regular power line, but it is generally best practise to have the entire Cottrell system independent. Separate generators, driven by motors operated from the main power line, are therefore usually employed. The system is also usually divided into a number of independent units, each with its own generator, transformer, rectifier, and set of pipes, so that one or more units can be shut down without interferring with the operation of the plant. It is essential that the rectifier revolve in synchronism with its alternating-current generator and so it is usually mounted on the shaft of its generator; but sometimes synchronous motors are used for operating the rectifiers.

Great care must be taken to guard the system from static surges. Powerful choke coils are mounted in the transformers for this purpose. Each transformer has a number of different, high voltage taps so that the voltage of the direct current can be adjusted to suit the conditions at the installation.

All switching and control arrangements are placed in the low voltage side of the system, the path of the high voltage current from transformer and rectifier to the precipitation pipes being kept as direct and simple as possible.



Close-up View of 100,000-Volt Mechanical Rectifier, Direct-connected to Synchronous Driving Motor. Note the Sparks at the Edge of the Revolving Disc.



Section Thru One of the Electric Smoke Precipitation Units. Several of These Are Used in the Chimney-path from the Boiler. The Soot Particles Are Electrified and Deposited Upon the Walls of the Chamber, the Latter Being Cleaned Out Periodically.

The power actually needed for precipitating the dust is insignificant in amount, and by far the greater part generated is absorbed as losses in the system. Hence the cost of operating the process is small.

Much has been said recently about the recovery of potash from cement dust. This valuable by-product is obtained by means of the Cottrell process.

IRON CRUCIBLES INSTEAD OF PLATINUM.

Platinum is more expensive now than at any time in its history and yet it is regarded as an indispensible medium as a crucible for use in analyzing certain compounds. It is, however, possible to dispense with it in analyzing ferro-silicon, an important alloy used in making steel. According to Dr. Herwig, in a German technical paper, iron crucibles can be used for this purpose if, instead of the usual carbonate of soda and potash method, sodium dioxide is used in the ignition mixture. Great care must be taken to reduce the ferro-silicon to as fine a powder as possible, to remove all coarse particles, and to mix the powdered silicon thoroly and very uniformly with the dioxide, as otherwise dangerous ebullition might take place, which would nearly empty the crucible and cause spattering.

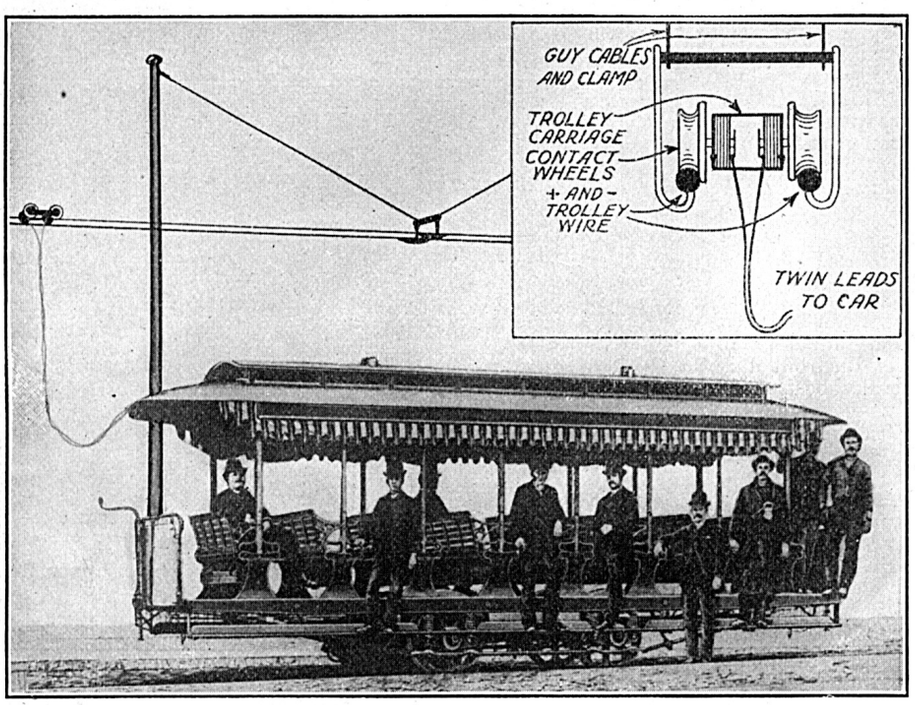
NEW WIRELESS STATION OPENED.

The newspapers of Willemstad, Curacao, S. A., recently began publishing wireless dispatches received by the new wireless station there. Dispatches are received from several European and American stations.

THE FIRST TROLLEY

By GEORGE HOLMES

A GREAT deal of historic interest is attached to the modern trolley car. Its evolution has been gradual and the present car is the result of many years of trials, experiments and failures, not to mention the many amusing incidents that went hand in hand with the early pioneers.



Yes, They're Old-timers—Heroes of the Initial Run of the "First Electric Street Car." The Now Familiar Trolley Pole Was Unknown Then. Instead, a Small Four-Wheeled Trolley Bogie Was Hauled Along, the Current Flowing In Thru One Set of Wheels and Out Thru the Other Two, Two Trolley Wires Being Necessary.

The first attempts in electrifying street cars met with great opposition from the then existing horse and cable car companies, and even the public was slow to grasp its full import. The few concerns which sprang up at that time used many and varied ways to induce the transportation companies to adopt the new means of propulsion.

It is amazing to note that the engineers in those days took on contracts for installations that even now would be considered "big chances." With hardly any factories for making such parts as were semi-standard, (for most of the installations varied pretty near as much as the weather) and the difficulty of securing funds and materials, they agreed to have cars running in such short periods of times as two or three months. Tracks, pole lines, power houses, cars and all the other paraphernalia!

The Bentley-Knight Co., had its shop on Tenth Avenue, New York City, where most of the equipment was made and many patents were granted them, among others being that on the underground "shoe" contact system. Frank Julian Sprague's early efforts also tend to show what difficulties were experienced by his company.

During a storm the overhead wires became covered with ice and the motorman had to get on top of the car and hack off the ice with an old broom.

The first trolley cars installed in Richmond, Va., were rather unique, seating but a few passengers.

The trial trip was to take place in the early evening with Mr. Sprague and his assistants; also most of the town was out to see the grand sight. The car ran fairly well until it struck the up-hill grade. On it's seven odd horse-power motor it labored up a little-ways, then pop went the motor. Mr. Sprague, who realized the car wouldn't make the hill, told the commission that some "testing" had to be done and sent one of his men to "bring the instruments." The crowd waited and waited as the hours past and finally left for their homes.

Mr. Sprague laid down upon the seats and went to sleep; about ten o'clock his assistant arrived bringing the instruments—two mules!!

Before the final car was made the engineers were pretty much on the go—every car was tested after a run (every half-hour) the road being about ten miles long. The brushes had to be replaced after each trip, as they were made of brass and occasionally the entire car was out of running order. Sometimes the brushes would arc and weld the particles of brass to the commutator segments, short-circuiting them—some fire works!! It used to cost some nine to ten dollars a day to buy brushes for a half dozen cars. Later on the present style carbon brushes were brought into use. Mr. Sprague stuck to his job, however, and among several hundred other inventions he is responsible for the multiple-unit control system now in use, whereby a train comprising any number of motor cars can be started and stopt from any individual car in the train.

In marked contrast to the first commercial trolley of uncertain progress, we show herewith the very latest "one-man" automatic trolley. The problem of providing better and more frequent service as demanded by growing communities, and at the same time reducing operating costs to meet the competition created by the so-called "jitney" automobile in the electric railway field has led to the evolution of various forms of light weight "Safety" or One-Man Cars.

This type of car is now in operation in many parts of the country and enables substantial economies in the direction of reduced power consumption per passenger haul, reduced car and track maintenance and reduced platform and operating expense, not to mention a relatively low first cost. For branch lines and territory having an intermittent traffic, this type of car appears to be especially well adapted.

While safety is fundamental in any operation of railway cars or trains, this factor is, of course, particularly important in the operation of the new one-man Safety Car. Where a single operator is entirely responsible for the control of the car and the sole dependence in the event of danger, such service demands that every automatic safety feature possible be provided in the system by which the car is controlled. In addition, practical economy and convenience argue strongly for the performance of all possible functions automatically.

The safety control devices are air operated and act in such a manner that the motorman must be at his post and attentive to his duties before the car can proceed and must remain alive and alert in order to keep the car moving. Should the motorman be incapacitated by sudden death or should he remove his hand for any reason from the

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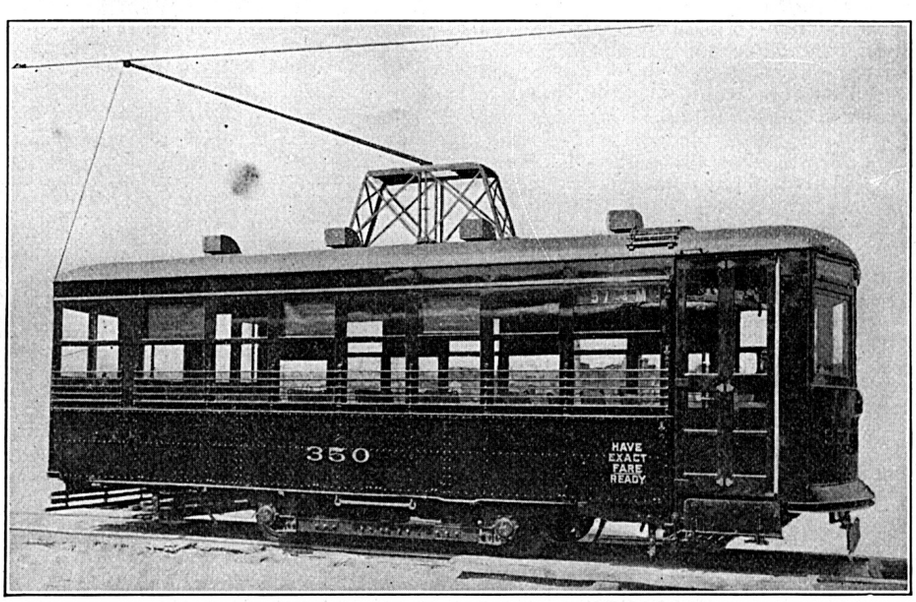
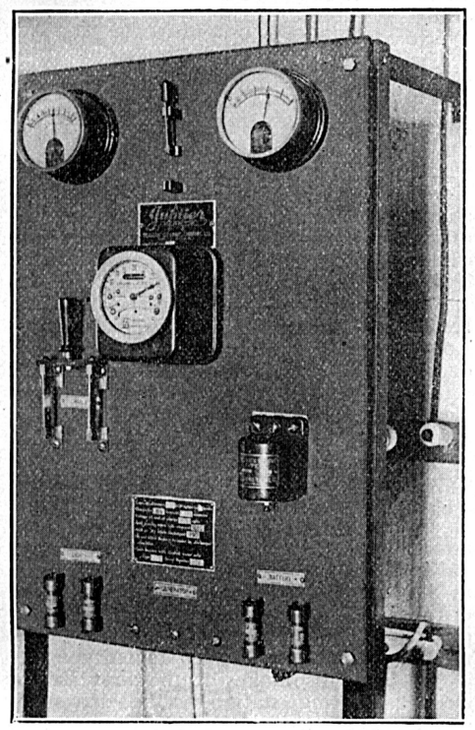


In Marked Contrast to the Early Trolley Car Shown Above, is this "One-man Automatic Trolley." It Is Built Like a Machine Gun. The Motorman Controls the Power, Brakes, Track Sander, Door Openers, Collapsible Steps, Bell and Lights.

Electric Power from the Wind

THE Fuel Administrator has had a hard time of it, trying to "educate" the people in all parts of the country to burn less coal. Coal is expensive to-day—and hard to get. Think how much easier would be the Fuel Director's problems if the land was dotted with thousands of electric wind-power plants of the type here illustrated. It is not necessary that such plants be kept small



Appearance of Automatic Electric Switchboard Used in Wind-power Electric Plants. It Cuts in the Dynamo When the Wind-mill Has Attained the Proper Speed.

like those seen here and there on farms thruout the country—they can be built in large sizes so as to develop hundreds of horse-power—even thousands of horse-power. Such a large wind-power plant for town and municipal utility is illustrated here and was designed by E. H. Manning of Tomah, Wisconsin.

The small farm size plant illustrated possesses several unique features which lend themselves well to the driving of dynamos.

The working parts of the mill are enclosed in weatherproof casings and these are filled with oil to insure perfect lubrication at all times. The steel tower extending above the wheel securely anchors the wheel at the top; the bottom is carried on heavy duty ball bearings, thus making a construction which will stand the most severe wind storm. Every bearing of service is a ball bearing, giving greatest efficiency at all times.

In operation the power vanes are each rotated on their respective bearing in such a manner as to expose them to the wind at the angle of greatest efficiency at every degree of the circle, while traveling with, across, and against the wind, there being about 30 degrees only of the circle when the vane comes against the wind edgewise to a degree where it is not efficient.

It thus becomes evident that all wind pressure is delivered at a given distance from the center of the wheel and that the power then is delivered to the power shaft, instead of acting as a barrier to the wind. This is one of the features which give greater efficiency to this type of wind power wheels.

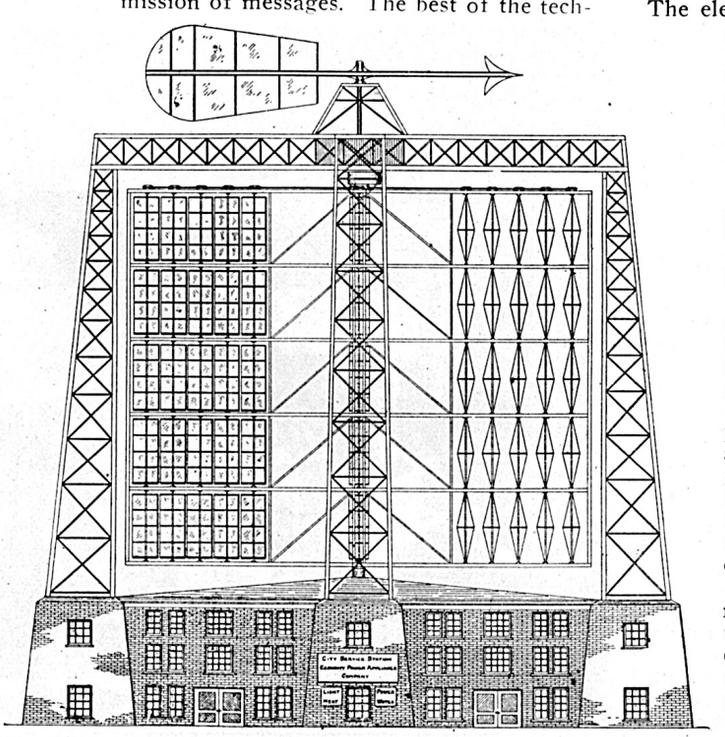
Another feature of this design of wind power wheel is the automatic controllability. By means of a centrifugal two-ball governor or by a resistance type electric governor, the vanes are varied in their angle to the wind in case of high wind velocity so that the motion of the wheel is kept from running above a given speed. This protects both the power plant and machinery from unnecessary wear and strain.

The automatic means for stopping the mill when the storage batteries are charged and throwing it in the wind when any given number of ampere-hours have been discharged, all simply means that when the plant is once properly installed you are assured of perpetual and abundant service, without further expense or attention except oil for the plant once a year, distilled or rain water for the batteries and reasonable attention to your generator.

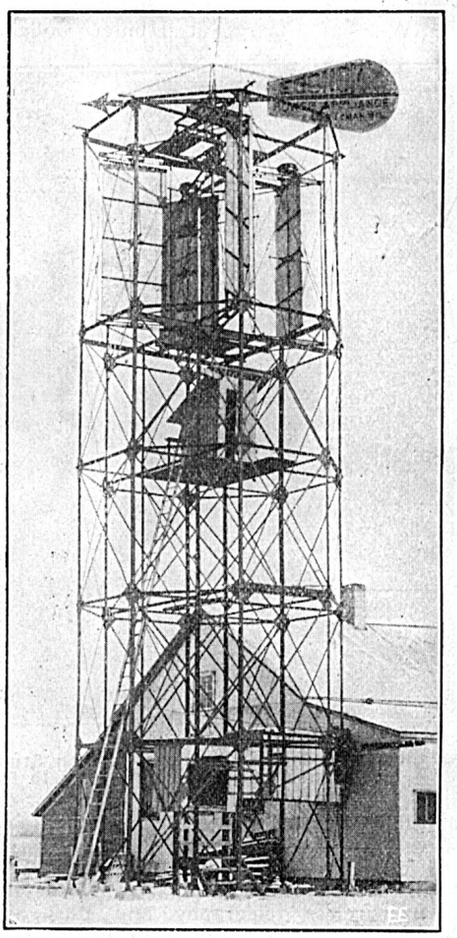
The small farm type plant here shown supplies electric power for a large group of buildings. It is automatic, starting and stopping according to the condition of the storage batteries. It charges the batteries about once a week on the average. One of the photos shows the electric control switchboard, including the volt and ammeters, automatic charging cut-out.

THE THIRD LIBERTY LOAN AND YOU!

This country had not been at war with Germany for many days before realizing the essential importance of the trained electrician in the Navy, in the trenches, behind the lines, at the various headquarters, and in Washington. To consider that city alone, and none of the others where war preparations are going on, the demand for electrical service is insistent. The War Department's system of communication with the outside world must be of the best. Here there must be no fraction of a second lost in the transmission of messages. The best of the technical minds of the country have been consulted on this problem and in the weeks just past there have been many adjustments in the interest of speed and efficiency.



Small Town Wind-electric Generating Plant Intended for Supplying Light and Power to a Whole Community.



American Wind-electric Generating Plant of New Design. It Charges a Storage Battery About Once a Week. The Plant Shown Supplies Electric Light and Power for a Large Group of Buildings.

The electrician in this war stands in the place of the ancient runner as a transmitter of intelligence. He may bear a message such as the first Marathon racer brought of the victory at Thermopylae. Indeed, the man who flashed the first word of the safe arrival of Pershing's force in France performed just such a service for the American people as did the messenger who gave up his life. The nation has been calling for the services not only of the electrical technician, but also of the man who dreams in terms of volts until he creates death-dealing and life-saving devices for use in this conflict. Never has the inventor taken so prominent a part in war. His ideas are being snatched up with the greatest eagerness in the hope that they may be applied to a weak spot on the Western front, to some condition of submarine warfare, or to the over-head warfare.

It has been impossible for most men to follow the development of the electrician in war times, fascinating as that subject may be. A more definite idea was presented at the recent exposition in New York City. Industrial lighting devices, for instance, have been

(*Continued on page* 796)

Women Now Study Wireless

A class in wireless telegraphy for women has been establisht at the East 86th Street branch of the Y. M. C. A. by Mrs. Herbert Sumner Owen, the founder and director of the Wireless Classes at Hunter College and the Marconi Radio School. The Y. M. C. A. offered the use of their apparatus and the services of their instructor Mr. Bohn to Mrs. Owen, so that women could learn wireless telegraphy and thus aid their country by teaching men and replacing them in many posts relieving them for active service in branches where they are more needed. The photo shows a class in radio engineering.

Eighteen women have already past the U. S. Government tests, hold licenses, and are thoroly capable of becoming code instructors, should the Government decide to use them.

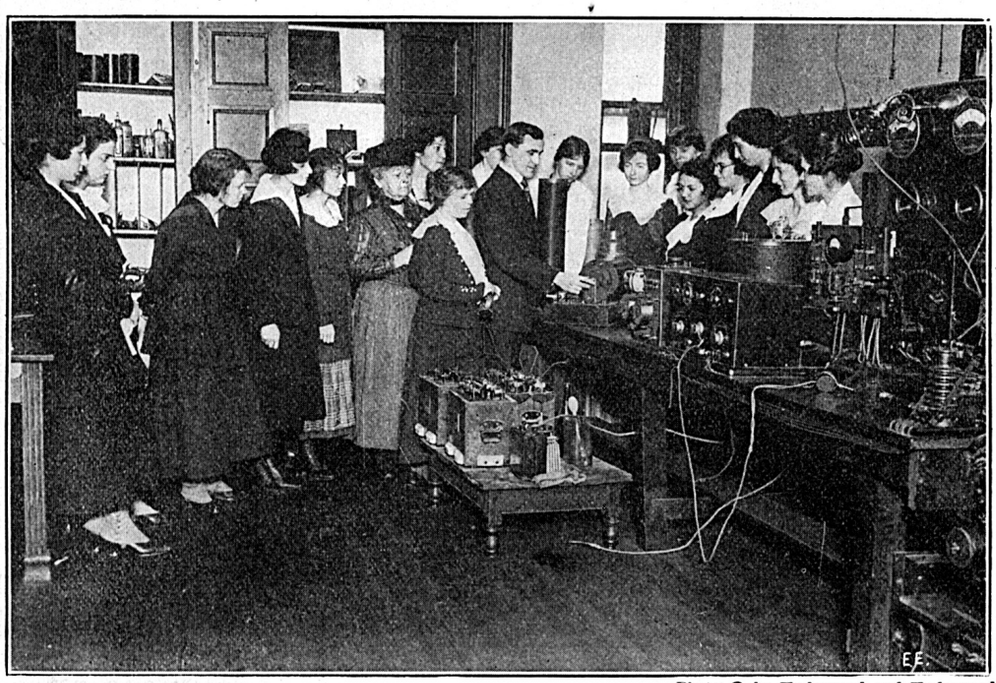


Photo © by Underwood and Underwood

An Interested Group of Young Women Studying the Mysteries of Wireless at a New York School, So as to Be Ready to Do Their Part When the Call Comes.

ANTILLES' RADIO OPERATOR DIED BRAVELY AT HIS POST.

Secretary Daniels has sent a letter to Robert Ausburne, who is employed at the Union Club, Fifth Avenue and Fifty-first Street, New York, commending the action of his brother, C. L. Ausburne, radio electrician first class, who went down with the U. S. Army transport *Antilles,* when it was sunk on October 17. Attention was called to the bravery of this radio operator in the findings of the court of inquiry, which stated that Ausburne went to his station to use the radio to give warning rather than attempt to save his own life.

Ausburne and Radio Electrician MacMahon were asleep in adjacent bunks, opposite the radio room, when the ship was struck. Ausburne, realizing the seriousness of the situation, told MacMahon to get his life preserver on. As he left to take his emergency station at the radio key he shouted to his companion, "Good-by, Mac." This was the last MacMahon saw of him. Going to the radio room, MacMahon found it locked, and, realizing that the ship was fast sinking, attempted to get Ausburne out, but without success.

Ausburne originally enlisted in the Navy at New Orleans, February 25, 1908. After eight years' service he reenlisted on March 1, 1916. He was one of the four men of the Navy who went down with the *Antilles.*

According to the report of the officer in charge of the armed guard on the *Antilles* the behavior of the Navy personnel thruout was highly commendatory. The two forward gun crews, in charge of Lieut. (Junior Grade) R. D. Tisdale, remained calmly at their gun stations while the ship was sinking and made no move to leave their posts until ordered to save themselves. An instance of remarkable coolness is cited in the case of one member of the gun crew who was rescued from the top of an ammunition box. When he saw a steamer coming near to pick him up he advised the ship by semaphore not to come too close as the box he was sitting on contained live ammunition.

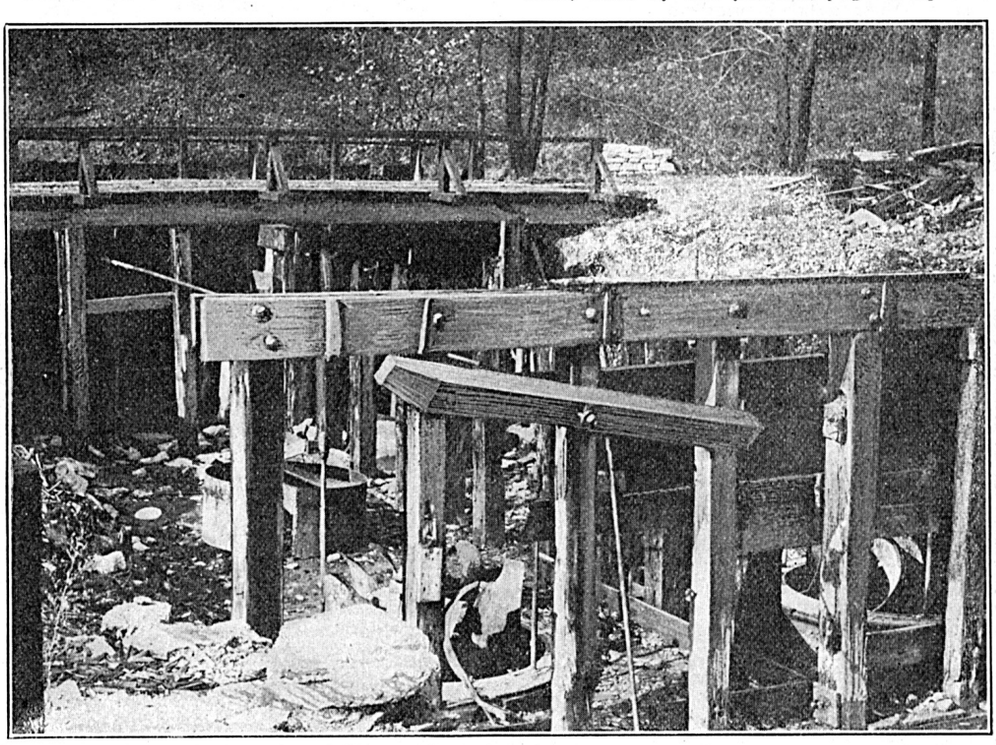
HISTORIC LIGHTING PLANT AT APPLETON, WIS.

The illustration shows all that is left of what is thought by many to have been the first commercial incandescent electric lighting plant in the world. This picture was taken recently by H. G. D. Nutting of the *Electrical World,* at Appleton, Wis. It shows the steel shells of the old vertical waterwheels now broken to pieces and lying on the ground. The wood construction is what is left of the harness and support, and on the other side of the little bridge are the needles holding the water back in the flume, which is till connected with the Fox River.

This plant has been mentioned by many writers and referred to by Samuel Insull in speeches and in reminiscences of early days. While it is held by some that it was the first incandescent lighting station in the world, recent researches of William E. Keily of Chicago, who has given considerable thought and time to investigating historical events in the industry, seem to indicate that this was the third Edison electric lighting station in operation.

According to the best data which Mr. Keily can obtain, the Holborn viaduct in London was started either on Jan. 12, 1882, or April 11, 1882, these two dates being fixt by separate authorities. The historic Pearl Street station in New York was started on Sept. 4, 1882. The record of the Western Edison Light Company of Chicago, which took the contract from the Appleton Edison Light Company for two K dynamos, to be operated from water power and to light 550 lamps, was dated Aug. 15, 1882. Edward T. Ames, still living in St. Joseph, Mich., was sent by the Western Edison Light Company of Chicago to install that machinery. He has stated that the Appleton station was started on Oct. 15, 1882. This makes it the first Edison electric lighting station to be driven by water power and the first Edison station in the West.

[*Editor's Note:—Those interested in the history of the first steam-driven electric central station in America will find an authentic article describing the Pearl Street station in New York City in the January, 1918, issue of this journal, page* 598.]



A Remarkable Photograph Showing What Is Thought to Be the Remains of the First Hydro-Electric Plant in the World. It Was Built in 1882, and Started on October 15 of That Year.

NOVEL ELECTRIC STRIP HEATERS.

For crane cabs, valve, meter and pump houses, watch and signal towers, turn table cabs, theatre ticket booths, exposed and remote rooms—these are some of the loca-

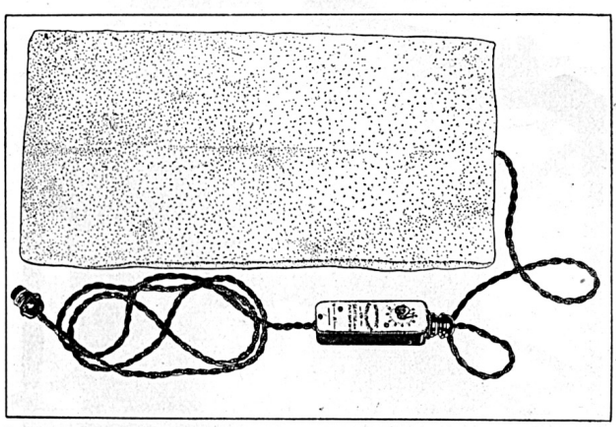
New Electric Strip Heaters Which Are Well Adapted to Heating Small Booths and Closets.

tions in industrial plants and factories where the new strip type, steel jacketed, electric heater units have found application.

These units may be connectecd to either D. C. or A. C. circuits—115, 230 or 250 volts. As electric lamps are placed where light is wanted so these units are distributed where heat is required. The dimensions are 3/16 x 1½ x 23¾. Such heaters take up a minimum of room and give enough heat to keep a small booth comfortable.

NEW AUTOMATIC CONTROLLER FOR HEATING DEVICES.

A Western concern is manufacturing an automatic controller that regulates the amount of current delivered to any heating appliance and maintains the heat of the appliance at an even temperature. This device is made in two types, one for alternating current and the other for alternating and direct current. The controller consists of a thermostat, composed of copper and iron riveted together, which is placed immediately over a heating coil and connected in series with the load. The heat from the coil causes the thermostat to break the circuit whenever the temperature rises above a certain point. The handle on the outside of the case can be set at any point lettered from A to K, on the scale. *A* corresponds with zero degrees, *B* with 10, and *C* with



An Automatic Electric Controller Operating on the Thermostatic Principle and Designed for Use with Heating Appliances, Such as Pillowets, Blankets, Etc.

160. The turning of the handle causes the contact point which touches the thermostat to move downward and bend the thermostat. Thus the more the thermostat is bent the more heat is necessary and the higher the temperature required to cause it to bend still further and break the circuit. By the use of this device it is claimed that 40 per cent of the energy now used in the excess heating of irons, percolators, toasters, chafing dishes, etc., can be saved, as the exact amount of heat required can be obtained and the excess eliminated.

3,000,000 H. P. AVAILABLE AT NIAGARA WOULD SAVE COAL.

C. A. WINDER, in a recent address here before the Schenectady Section of the American Institute of Electrical Engineers, urged the use of Niagara Falls power as one means of solving the coal shortage problem. Mr. Winder spoke as follows:

"While the Nero of smug indifference and ignorance is fiddling away, the great coal fields of the earth are being burned up. While millions of horse-power are passing unused over vast water falls, great industries are languishing. Water power sites have virtually been roped off and *'Verboten'* signs posted by our national legislators. Now that the coal supply diminishes and water power is throttled, what chance has the electrochemist, the greatest user of power, to expand to meet the increasing demands of the present day? The electrochemical industry is vital to the success of the great world war; that water power is vital to this industry will be shown in the following paragraphs," he said in part.

"The electrochemical industry can be well divided into three classes.

"First—Those that can't be moved from the country by any means and will stay regardless of the cost of power.

"Second—Those existing at present, and to a greater or less extent depending upon natural conditions for existence and growth.

"Third—Those having no footing in the country or not as yet in existence.

"The first includes copper, zinc and rare metal refining and electric steel production and is perhaps, as a class, the largest user of power. Class two included, in the order of their importance, the following: Aluminum, ferro alloys, carbid, artificial abrasives, alkali, chlorin, phosphorus, sodium, cargon, disulfid, grafite and similar products. Class three would then include nitrogen fixation and possibly products we know little or nothing of at this time, there being no power consumed within our boundaries for products of this class.

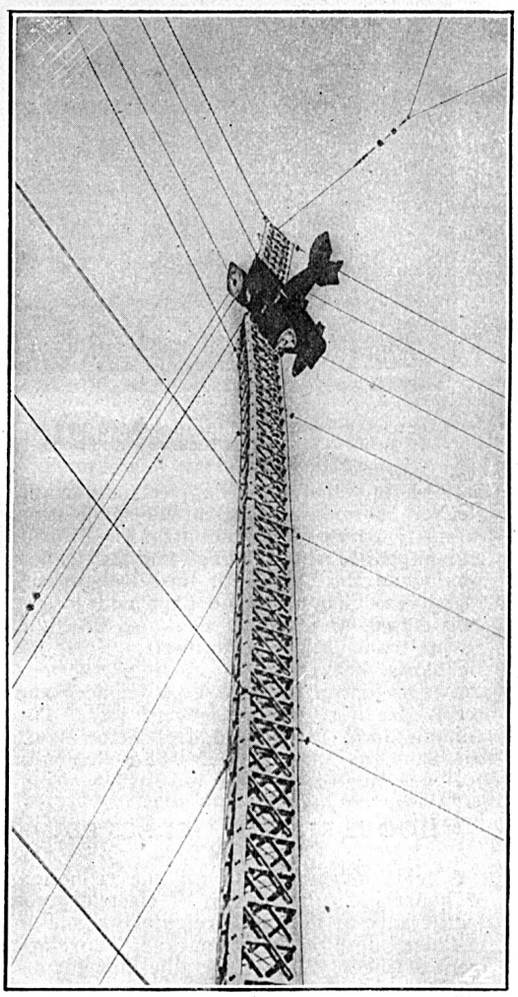
"Not a shell is made that is not shaped by electrically made abrasives. The electric furnace from which the armor plate is poured used electrodes made from coal by the aid of electric power, the resisting power of this same steel is given by electrically made ferro alloys. Merchant vessels are now using smoke buoys in which quantities of phosphorus and other electrochemical products are burned, emitting large quantities of smoke, thus protecting the boat from the submarine. High explosives utilize chlorin, aeroplanes, aluminum, and observation balloons produced by the aid of silicon. In fact, every tool of the modern army is in some way dependent on the electrochemical industry. Furthermore, our military preparations are already calling for very considerable quantities of many electro-chemical products for which ordinary demands are small or non-existent and which were therefore not produced at all or produced in extremely small quantities. The increased demand for our vast army will be enormous. England, for instance, always

(*Continued on page 792*)

SEAPLANE CRASHES INTO RADIO TOWER.

The extraordinary and remarkable photo here reproduced shows a British seaplane caught in the steel girders of a wireless tower over 300 feet high. The plane, while emerging from a thick mist, hit the tower and was caught firmly in the steel lattice work. The pilot, who was stunned, was flung from his seat and fell on one of the planes, where he lay unconscious over 300 feet from the ground. The seaplane's engines were wedged into the interstices of the girders so that the body of the machine stuck out at right angles.

A small body of bluejackets were at work painting the tower. One of them, a seaman of the Naval Reserve named Rath, climbed up the inside of the mast until he reached the machine, and then crawled out onto the plane to hold the pilot until help came. Two more men, Ordinary Seaman Knoul-



A Remarkable Accident Which Occurred in England, a British Seaplane Being Caught in the Steel Girders of a 300-Foot Radio Tower. The Aviator Was Rescued, Miraculous as It May Seem.

ton and Deckhand Abbott, past a rope out to him, which Rath secured to the body of the pilot and lowered him to safety. The gallantry of these men is accentuated by the fact that the mast was badly damaged, and might have at any moment collapsed. The damaged fuselage was only held in a horizontal position by the engine being jammed between the girders, and at the height of 300 feet the wind caused the mast and the machine to sway severely, threatening to fall. The pilot owes his preservation to the intrepid gallantry of these three men, who, while alive to the risks they ran, performed the rescue without regard for personal safety. The Albert medal will probably be awarded them for their bravery.

JUMBO GETS HIS HIDE VACUUMED.

Jumbo, the elephant, likes to have his hide cleaned the modern way, that is, with a vacuum cleaner. The illustration shows a husky pachyderm receiving his morning bath—à la vacuum. The electric vacuum cleaner is finding wide-spread application in many parts of the country for thoroly and expeditiously cleaning animals. Time was when the only bath the elephant enjoyed was that when he happened to get near a tank of water or a lake so he could fill his trunk and spray himself. Now, the elephants belonging to such pretentious shows as that at the New York Hippodrome receive a thoro cleaning every day. The animals look better and feel better—just the same as humans do. The elephants really seem to enjoy the novelty.

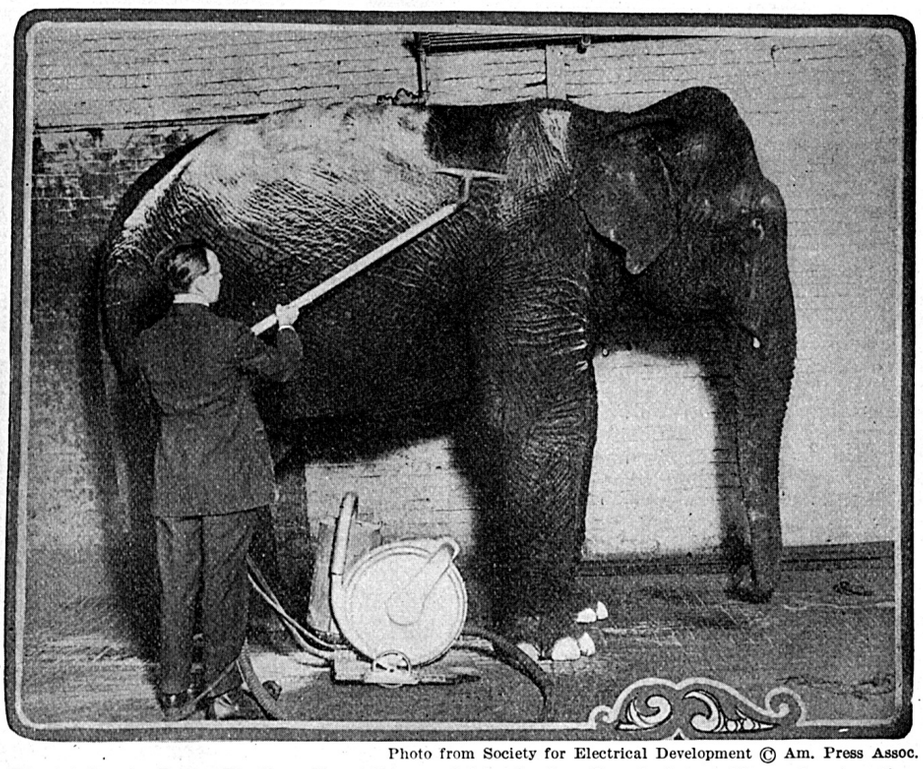


Photo from Society for Electrical Development © Am. Press Assoc.

Electricity Is Daily Finding More Ways of Lightening Our Labors—Here, Jumbo, the Elephant, Receives a Thoro Morning Scrubbing—a la Vacuum.

"HOOVERIZING" ELECTRIC CURRENT.

A wide margin exists for the reduction of household consumption of electricity, in furtherance of fuel and freight saving. For instance, despite the remarkable development of cheap, durable, metallic-filament incandescent lamps the past few years, there has been no reduction whatever—in fact, an increase, rather—in the use of old-fashioned carbon-filament lamps, which the modern lamps should have displaced, says the weekly bulletin of the U. S. Food Administration. Carbon-filament lamps give less light than modern lamps and consume more electricity. The chief element in their continued use is the fact that they are given free to householders by many electric-light companies, whereas metallic-filament lamps are sold. It would pay every consumer of electricity many times over to purchase modern lamps and economize by reductions in electric-current bills. Old-fashioned and ineffective types of lamps are also used for street lighting and should be replaced with large economical incandescents of the latest types.

ELECTRICAL PRODUCTION OF RAIN.

According to an Australian patent applied for by Mr. J. G. Balsillie, of Victoria, electricity can be utilized to promote the falling of rain over dry regions.

The specification states that the atmosphere is known to comprise several distinct regions. The section of the atmosphere concerned with the process subsequently described is termed the troposphere. The earth's surface is always negatively charged, and in fair or clear weather the troposphere is nearly always electrified positively; in wet weather, however, negative electrification of it is usual. The troposphere contains transient masses of electrified particles which vary or alter the normal sign and potential gradient of zones of the troposphere. The invention is based on the diminution or cancellation by artificial means of the potential gradient existing in fair or clear weather between the elevated zones of the troposphere and the ground, so that clouds are formed in the affected troposphere zone and rainfall is procured. The invention utilizes an electrical conductor used to form a path for a flow of energy between the earth and such tropospheric zone or cloud, the conductor being connected to a good electrical earth at the lower end, and at the upper end having a terminal of electrically conductive material which will insure intrinsic electrical connection with the cloud or tropospheric zone. A potential of the order of 320,000 volts is maintained between the conductors, causing coalescence of the aqueous particles and deposition upon the earthed conductor. In a modification a single earthed conductor is supplied with high tension alternating-current by means of an alternator inductively coupled by a transformer with a closed oscillating circuit, comprising a spark-gap and a condenser, which, in turn, is coupled through a tuning coil. Deposition of the aqueous particles occurs upon and in proximity to the conductor.

HEAVY DUTY ELECTRIC PHOTO-PRINTER.

By V. G. Ellis.

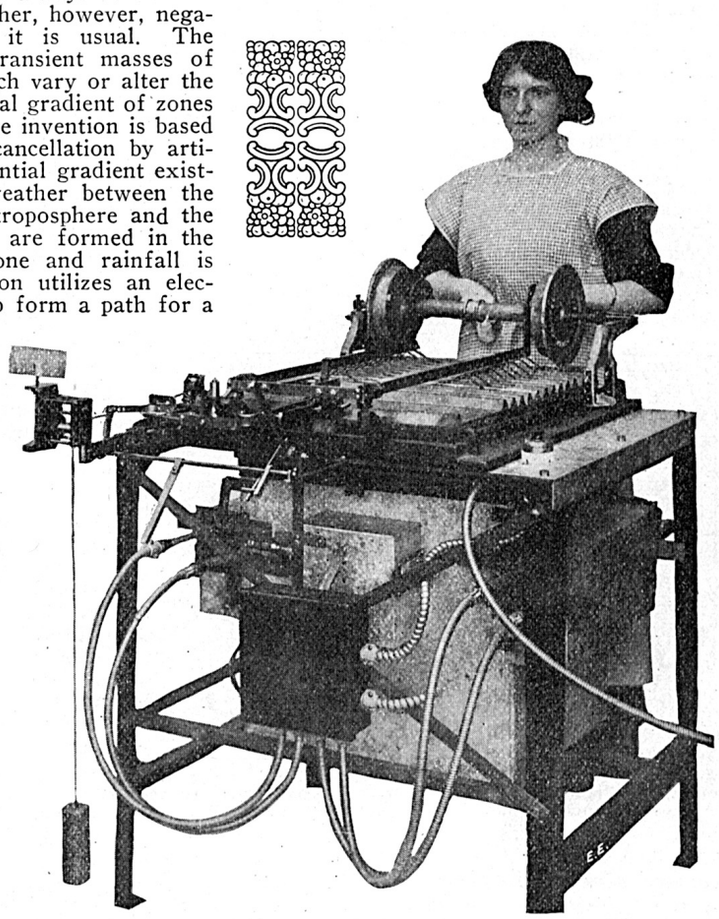
This photographic printing machine is in use by a concern making large commercial photographs in big quantities. It has an automatic time switch making and breaking the circuit for six 500 watt tungsten lamps about once every minute, all day long. By means of a clock-work, it is set to give a print any desired length of exposure to the light. Each lamp can be turned on and off individually as well as adjusted in different positions so as to regulate the intensity of the light on certain parts of the negatives to be printed.

The switch has sliding contacts, mounted on a marble base which is inclosed in a sheet metal box. The wiring is arranged as shown in the photograph of the device.

The automatic switch terminals are of brass, insulated by fiber over which a flexible copper bar moves with perfect contact and without appreciable friction.

As the bar slides over to the opposition it lights a red pilot lamp, thus furnishing illumination in the machine while the photographic paper is being put in place over the negative. When the switch bar is half way across the contacts the red lamp is connected in series with the white lamps, preventing the current from being entirely broken at any time during the operation.

Before this machine was perfected great difficulties were experienced on account of arcing switches and unreliable timing, but this construction has given the users satisfactory service for several years.



With This New Electric Photograph Printer the Young Lady Can Turn Out Ten Photo Prints Where One Was Produced Before.

AN ELECTRIC SHELL FOR FIGHTING U-BOATS.

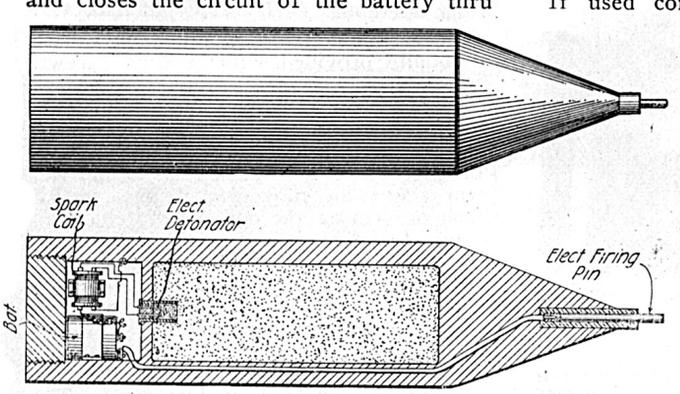
It has remained for Mr. Lee A. Collins, of Louisville, Kentucky, to invent a new electric explosive shell for combating submarines.

This shell is one which explodes after being fired from a gun or other projectors or when dropt from airplanes and the like into the water, for warfare against submarines, torpedoes and the like. The inventor provides in this connection two electric conductors exposed to the outer surface of the shell with insulating means separating the electric conductors. This insulating means is soluble or made conductive when in water. Another object of the invention consists in providing a normally open circuit adapted to be closed upon contact of the two exposed terminals with water or other conductive means, thus causing an explosion. By attaching time fuses to the electric detonator it is possible to cause an explosion to take place at a predetermined time after the shell comes in contact with conductive means, instead of the instant that the shell strikes conductive means.

The invention also covers means for coating outer exposed conductors with a non-conductor covering, such as sealing-wax, paraffin or other suitable means which can readily be removed when shell is to be fired, thus preventing accidental contact, which would prematurely explode the shell.

These exposed conductors must have all insulation covering removed at outer exposed surface when ready for use. Heavily insulated covered conductors lead from the secondary of spark coil and thru wall separating the chambers to the respective terminals of a detonator, which may be of any suitable type. One form being a bulb containing fulminate of mercury and a platinum wire within, connecting the electric terminals leading from the spark coil. The detonator is in contact with or rests against the explosive, which may be a charge of guncotton or other high explosive, placed within the forward chamber. Obviously, therefore, as soon as the platinum wire within the detonator is energized from the spark coil, the explosive explodes, thus causing destruction to the shell and all objects within reasonable radius.

In operation, when a shell is fired from a gun or dropt from an airplane or otherwise discharged into the water at an enemy vessel, submarine or torpedo, one conductor and the outer portion of the shell, which in this form is a conductor, will come into contact or be submerged into the water when it strikes the point of aim and closes the circuit of the battery thru the primary of a spark coil. As a result, the primary of coil will induce a current into the secondary of the spark coil and energize the detonator thru wire. Upon energization of the detonator the explosive is exploded and, of course, will destroy the shell and any objects within its radius such as submarines, torpedoes or other vessels.



Electric Shell For Fighting Submarines. When Dropt In the Water It Becomes Active Due to Insulation Being Dissolved At Point, Closing Detonator Circuit.

In lieu of a spark coil a more powerful battery may be used and the ignition wires would be connected directly to the terminals of the detonator. Under some circumstances, it may be more desirable to form the insulating medium of dry salt or like mineral, which will readily become a conductor of electricity upon coming into contact with water and thus close the battery circuit to the spark coil.

A NEW SECRET TELEPHONE TRANSMITTER.

In order to permit privacy in telephoning, a Chicago inventor has developed a device shown in the accompanying illustration which can be used with any telephone mouthpiece. By its use, it is said, that telephone conversations can be conducted in a very low tone and in a whisper, under many conditions. It is pointed out that the device is not permanently attached to the telephone and is therefore not a fixture.

The device is held on the mouth-piece of any telephone, and is held securely by means of the horse-shoe shaped wire held by the two springs, which snaps over the mouth-piece of the telephone.

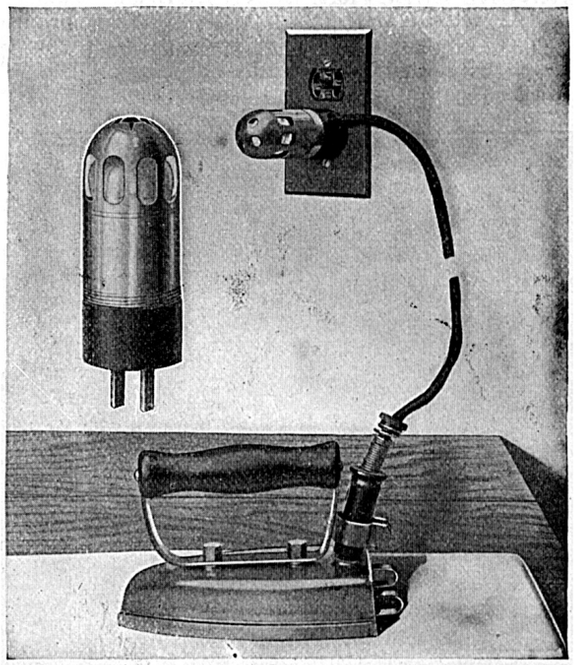
To use the muffler most effectively, the inventor states that the upper lip should be prest gently against the mouth-piece, speaking slowly and articulating distinctly *with the lips*—almost a whisper (not down in the throat).

A Newly Marketed "Secret" Telephone Muffler. It Fits Onto Your Regular Telephone and Is Removed In a Second.

If used correctly you will be plainly heard at the other end, it is claimed, and no one near you need hear your conversation, thus permitting privacy and confining business and personal affairs strictly to yourself and those with whom you talk

In Peoria, a hilly city in central Illinois, 300 automobilists operate automobiles without gasoline, that being the number of electric pleasure vehicles used in the city.

One ton of saffires will be used during the year 1918 in one factory where the jewelled bearings of electric meters are made. The jewels are purchased in the rough and are put thru finishing and drilling processes which require a degree of skill comparable only to that of an experienced watchmaker.



Something Every Housewife Wants—a Positive Indicator That the Electric Iron Is "On" or "Off." The Tell-tale Lamp Solves the Problem.

PILOT LAMP WARNS WHEN ELECTRIC IRON IS ON.

A new heater control just brought out is equipt with pilot lights which serve as a safety check on the woman who uses an electric iron or other extension device and on the workman who operates an electric iron in a factory, clothing shop or similar commercial establishment.

They enable the operator to play safe and avoid waste of current. The pilot light acts as a silent watchman and signals *danger* when the heating device is left in circuit unattended.

Take the case of an electric iron, for instance, on an ordinary padded ironing board: place it in circuit and leave it, with "heat on," for say fifteen minutes or more. The probabilities are that quite an impression will be made in the pad, and quite possibly on the board also; perhaps the iron will even burn its way right thru the board. And then again, if the iron is left to itself long enough with the current on, the chances are that a serious fire may result. These new Heater Control switches have been brought out particularly to minimize fire hazard of this sort.

A wide variety of designs has been made to suit practically any condition desired. Each includes a pilot lamp and a 10-ampere double-pole indicating switch.

The flush types are mounted behind attractively finished face plates, and the pilot lamp signals thru a ruby bull's-eye. They are ornamental in appearance and are designed especially for use in the home.

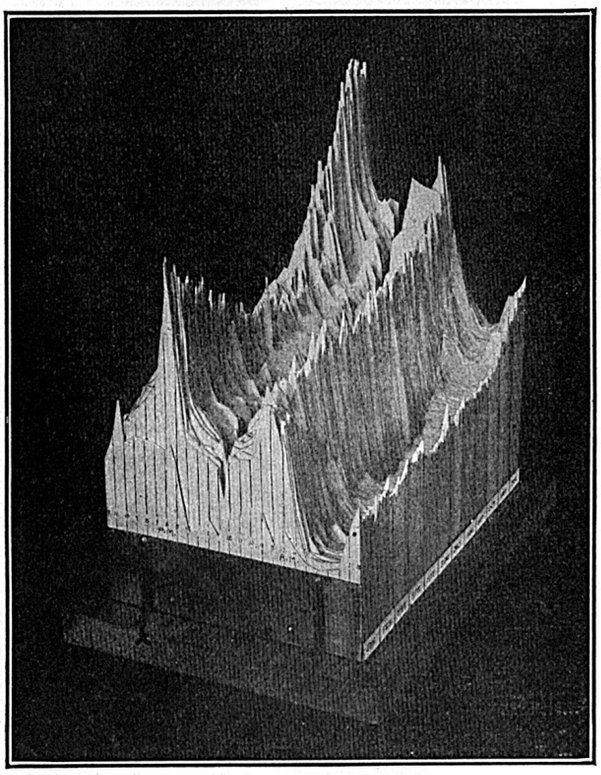
Surface types are for use in factories. They provide for regular base lamps as pilots but candelabra base lamps may be employed by using adapters.

USING EXHAUST STEAM.

More attention than ever before is being paid this winter to careful use of exhaust steam in power plants. It may be applied to innumerable purposes, such as heating feed water for the steam boiler, for many washing purposes, heating buildings, pasteurizing and sterilizing, and the like. A small investment in additional boiler-room equipment, such as an exhaust-steam heater, will effect savings of several hundred dollars a year in the coal bill of even a moderate sized power plant.

ANNUAL ELECTRIC LOAD RELIEF MAP RESEMBLES "ROCKIES."

The familiar daily load diagram or "graph" is plotted by practically all electric light and power companies. The accumulation of these curves soon becomes a mere record, usually filed away in some manner and always available for reference, and for the study of load conditions. When considering the load thruout the year it is difficult to obtain a comprehensive idea of the whole since it is necessary to glance *separately* at the greater portion of 365 sheets. Such a record locks up a desired vision in confusion.



No—This Is Not a Picture of the Alps! It Is a Composite Load Relief Map, Showing the Rise and Fall of the Electric Power Consumed in Philadelphia, Day By Day, For One Year.

The Annual Load Relief Map here illustrated is a device for visualizing the entire load of the year and is described by Wm. Le Roy Robertson in the A. I. E. E. proceedings for December, 1917. Each daily load diagram is marked off on card board and cut out. The cards are stacked up in proper daily sequence, mounted and provided with graduations for kilowatts, hours of the day and months of the year, all properly arranged. The annual load relief map here illustrated shows the Philadelphia load during the year 1916.

Day Load. A distinctive feature brought out by the annual load relief map is the contour of the day load which is consistently uniform throughout the year, always picking up between 7:00 to 8:00 a. m., having a valley at noon and then falling off punctually at about 5:00 p. m. This stands out clearly on the annual load relief map, and especially well, if one will imagine the absence of the night load where it overlaps the day load at 5:00 p. m. The day load corresponds closely to the regular average working day.

Night Load. The night load which picks up rapidly at 8:00 p. m. in mid-summer, and at about 4:30 p. m. to 5:00 p. m. in winter, corresponds closely to the lighting load. It depends absolutely upon the hour of sunset for its beginning and falls off rapidly, shortly after reaching its peak value. After midnight, it settles down to a low value and drops off almost entirely when the street lighting goes off near sunrise. In summer a deep valley will be seen in the morning, between the "fall-off" of the night load and the beginning of the day load, while in winter the loads overlap in the morning, filling up this valley.

Peaks. During the summer months there are three distinct peaks—one occurring about 8:00 a. m.; one about 5:00 p. m.; and the third about 8:00 p. m. With the approaching fall and winter months, and as the sun sets earlier each day, the 8:00 p. m. peak moves back toward the 5:00 p. m. peak and near the end of September the two peaks overlap, giving a combined peak greatly exceeding any other peak, which rapidly increases in height until the middle or latter part of December, when it becomes the greatest peak of the year. As the spring months approach the combined peak diminishes and finally near the end of March disintegrates, forming again the two separated peaks. While the above is a well known fact, the annual load relief map presents the changing condition in a most striking manner.

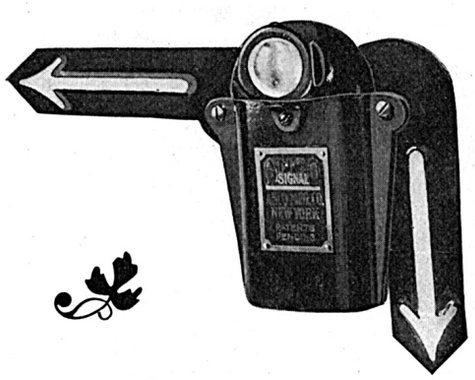
NEW AUTO TAIL LIGHT SIGNAL.

A novel automobile signaling device is provided in this new attachment for motor cars. It is claimed by the concern now offering this new signal to the public to represent an added convenience and comfort to motoring. It was perfected by H. Hartman, a well-known New York inventor.

Usually the driver of his car has to extend his arm from the seat to warn other cars in the rear, of what direction he is going to turn or if he is going to stop. By the aid of this new electrical invention, all one has to do is to push a button on the steering wheel and the arm will indicate which way the driver intends turning. When the car is going to stop, both arms fly up.

Two buttons mounted on a small base are attached to the steering wheel—one for *right* and one for *left;* when both buttons are pushed the stop signal is set.

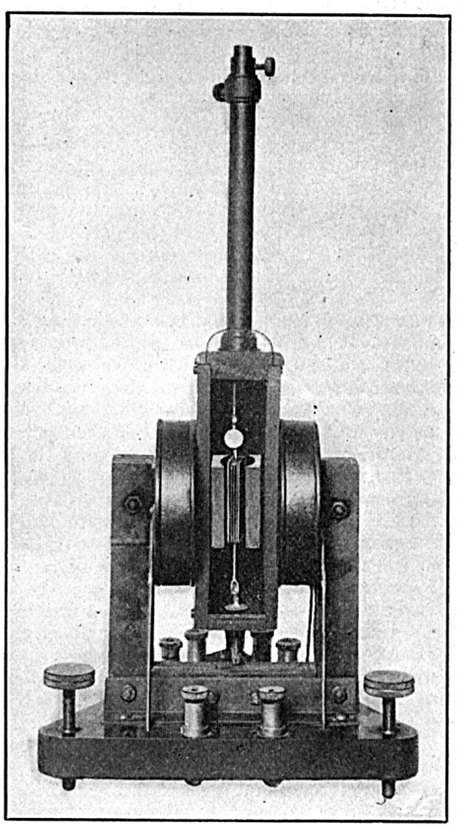
To inform the operator that his signal is working O. K. a small lamp flashes up on the push button base and a red light shows on the attachment. An ingenious arrangement flashes a beam of light on either or both arms so that they may be seen at night. The arms are worked by solenoid magnets, which close contacts for the lamps at the same time. An ordinary 4.5 volt battery, such as used in pocket flashlights, is sufficient to work this signal.



An Electric Semaphore and Tail Light For Autos. Its Arms Point to the Direction Which the Auto Is About to Take.

ALTERNATING-CURRENT GALVANOMETER.

Herewith is illustrated the new Northrup alternating-current galvanometer. The maker points out that it is especially adapted to the following uses: (1) For the accurate measurement of the resistivity or conductivity of salt solutions and other electrolytes; (2) for the measurements of the resistivity of molten salt; (3) for the measurement of the resistivities of molten metals; (4) for the measurement of any resistance in which small irregular emfs. exist; (5) for the comparison of small inductances using the bridge method and (6) for the comparison of capacities using the bridge method.



Something Every Laboratory Requires Is a Good "Alternating Current" Galvanometer. This Is One of the Latest Types, Fitted With Reflecting Mirror.

The galvanometer is mounted on a base of ebonite provided with leveling screws. The field magnets are laminated. Magnetizing coils are wound on non-metallic spools, which are placed on the field poles as close as possible to the moving coil. Pole-pieces are given a hollow cylindrical form about the moving coil, this special shape preventing the coil, when on closed circuit, from assuming a position of unstable equilibrium due to currents induced in its circuits by the alternating magnetic field. The moving coil is long and narrow, so that its moment of inertia is small, thereby permitting high sensitivity with a quick period. The entire hanging system is exposed to view through a glass front. The central housing is of non-conducting material to prevent the formation of eddy currents.

The sensitivity is adjustable thru a wide range, the strength of magnetism being variable by varying the current thru the field coils.

A LUMINOUS BUTTON FOR PULL CHAIN SOCKETS AND SWITCH PLATES.

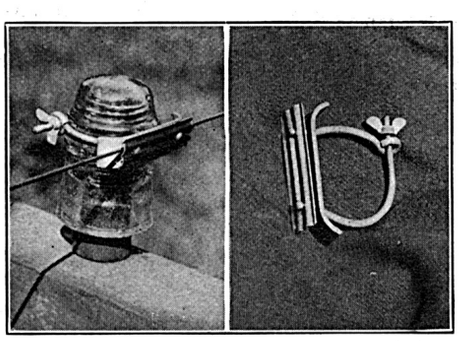
For attachment to the end of the pull chain of the pull-chain type socket and for

By Attaching This Luminous Bead to Socket Chains and Switch Plates, It Becomes An Easy Matter to Locate Lamp Control Points in the Darkest Room. They Glow in the Dark.

use with switch plates, a New York concern is now offering the trade a special radio bead and radio button which makes it possible to quickly locate in the dark a light chain, push switch or gas jet. These beads and buttons are made up of such a size as to radiate ample light, it is claimed, to be plainly seen at distances from 10 to 15 feet. The bead is made up so that it can be easily attached to the pull chain by cutting off the large ball at the bottom of the chain and slipping the last ball into the enlarged portion of the top of the bead and then pinching the wires close together. Besides the uses mentioned, it is pointed out that these devices are of practical use in lofts and cellars, where it is difficult to locate obstacles and lamps under other conditions.

NEW INSULATOR CLAMP REPLACES TIE-WIRE.

The insulator clamp shown is designed to prevent line trouble caused by the use of copper tie-wires on telephone and other lines. Besides preventing line trouble, it saves time when constructing new lines and also when repairing and rebuilding old lines, as it can be detached and attached more quickly than tie-wires. This clamp can be used over and over again, whereas tie-



To Save Miles and Miles of "Tie-Wire," An Inventor Suggests the Use of This New Insulator Clamp.

wires have only "junk" value when once used.

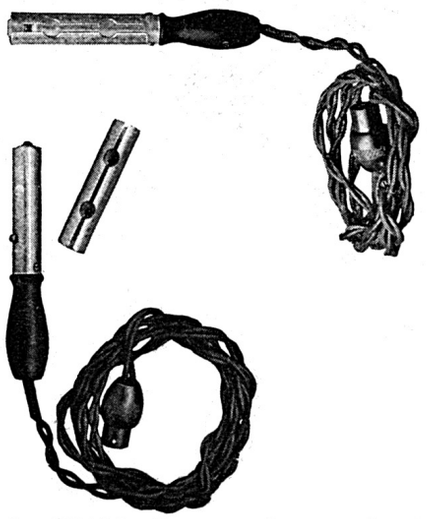
The cost of manufacturing is but little higher than that of the copper tie-wire.

Contributed by A. J. VIKEN.

AN ELECTRIC CIGAR AND PIPE LIGHTER FOR AUTOISTS.

Push the button and light your cigar or pipe without a cuss word, if your car is fitted with this new electric lighter. It is made for 6 volt storage battery only, and not for regular electric lighting or power circuits.

This Cigar Lighter is very neat in appearance, takes up little room, will not "drain" the battery and will add greatly to the equipment of the finest and most luxurious of cars. The spiral coil element is so arranged as to allow its use with cigar, cigarette or pipe. The casing is finished in polished nickel and the handle is of wood with ebony finish. It is furnished complete with protector sleeve and five foot cord directly connected to lighter and either one or two point Edi-swan standard automobile attachment plug.

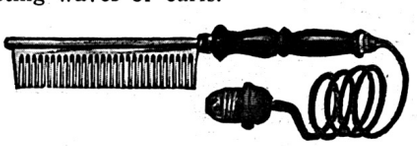


Every Autoist Will Appreciate the Comfort of the Electric Cigar Lighter.

A COMBINATION ELECTRIC CURLER, HAIR DRIER AND WAVER.

Ladies, both young and old, will find this new electric curler, hair drier and waver—all three in one—a great convenience. It dries the hair quickly after a shampoo.

To use the curling iron it is simply necessary to remove the comb. To use the waver, remove the shield and comb. The device is claimed to produce beautiful lasting waves or curls.



An Electric Curler, Hair Drier and Waver For Milady.

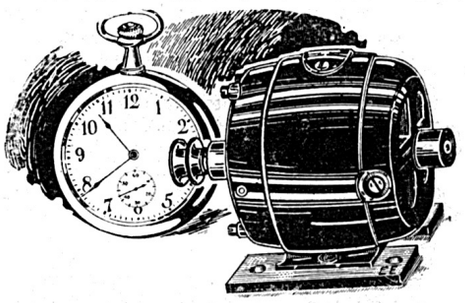
The heater and cord revolve together, so that the cord does not kink while in use and the temperature is so regulated in the heater that it cannot burn the hair.

CLEANING WARSHIPS' HULLS BY ELECTRICITY.

The old methods of cleaning ships' hulls, which was a laborious and lengthy process, is being replaced by electrical methods. Formerly, it was customary to allow 170 to 200 man-days for the work, but recently several electrically-driven machines have been found to be both speedy and effective. Brushes and scrapers are used, and by their means, at a moderate expenditure of electricity in driving the operating motors, an 18,000-ton battleship can be completely cleaned in twelve hours, and vessels drydocked after having been cleaned by this method have been found to have remained quite free from any subsequent marine growth.

COMMERCIAL 110 VOLT MOTOR SIZE OF YOUR WATCH.

One of the largest electric motor manufacturers has brought out a line of extremely small motors in every size from 1/200 to ¾ of a horsepower. Like a good



Commercial Electric Motors No Larger Than a Watch Are Now Built Regularly.

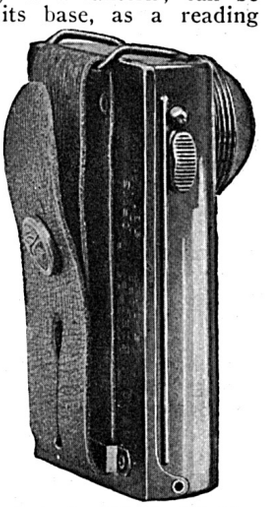
watch, they run sure and true, doing the work to which they are assigned, year in and year out, with little or no attention The 1/200 horsepower electric motor here shown in comparison with a watch shows how the electrical engineers have developed and perfected the motor so that a perfect machine, armature, field winding, bearings, and all results in a minimum of space.

WAR INVENTIONS CLOSELY GUARDED.

Pursuant to recent legislation empowering the Commissioner of Patents to withhold the issuance of Letters Patent on the devices adopted by the Government for use in carrying on war, Commissioner Newton has refused patents on over sixty-five inventions within the past few weeks. At the present time a corps of West Point and Annapolis graduates trained in technical problems of war, carefully consider the hundreds of patents granted weekly for details of military significance and choose those on which patent proceedings should be suspended during the war. The inventors thus deprived of patent rights may offer their devices to the Government and sue after the war for compensation.

NEW ARMY FLASHLIGHT FOR U. S. SOLDIERS.

This new army flashlight is designed especially to meet the needs of soldiers and sailors. It is small in size, light in weight and can be conveniently carried in kit or coat-pocket. It is claimed to give more light than many very large flashlights—plus special service impossible with ordinary types of flashlights. For instance it can be buttoned on the coat, leaving both hands free; can be fastened on the belt; can be hung on any peg; can be carried by its handle, as a lantern; can be stood upright on its base, as a reading lamp; can be hung above a mirror, as a shaving light. Renewal batteries can readily be purchased in any town in the United States and Europe. It is especially adapted to the wants of the Home Guard and Boy Scouts. For policemen, watchmen, detectives, reporters, sportsmen and all other classes of men who need to have both hands free, this lamp should prove extremely useful.



Latest Army Flashlight for Soldiers.

At War With The Invisible

By R. and G. WINTHROP

TO you of the present generation, secure and prosperous in these happy days of universal brotherhood and peace, the world-destroying War of the Planets, that engulfed every shred of our vast planetarian system at the opening of this century and pitted with frightful force planet against planet, is already becoming a mere tradition—a gruesome, historical record of the unwise past.

As you glide along the turbid canals, on your summer trip to Mars, with the peculiar reddish water lapping at the sides of the blunt-shaped gondolas, you pause for a few moments to contemplate the enormous magnetic pillars from which were launched the world-crushing electrites; or you climb the grass-covered Battle Hill on Venus to gather souvenir fragments of the crumbling Flame Tower, whose battered sides now seem to be sinking into the crest of the hill. But, strive as you may to revive the images of that bygone age, your interest is only historical and you cannot sense the the feeling of horror that comes over us older people when we revisit these time-scarred, battle-seared scenes of a past in which we struggled against complete extinction.

I do not expect, therefore, to reproduce in your souls the emotions that moved me in that time of strain and stress—I cannot hope to picture in your minds my own mental conflicts of dread and triumph, of life and love and hope, when a fear-maddened universe fought desperately against a new force—more bitter and relentless than any that warring mankind had ever before faced—the Invisible Armada of the Air. But I want to bring vividly to your minds the knowledge of that event, one among a thousand of the Great War, so that you may see how the Supreme Intelligence, working thru the mind and hand of man, rewards fiendishness and malevolent ambition.

It was in the year 2011 that Mars thrust this new engine of frightfulness into the strife. The terrific struggle was ending its third bitter year and the contest between righteousness and unholy greed seemed to be ending with victory on our side. As the real character of the war had become apparent, one after another the planets had joined the forces pledged to destroy the menace of Martianism. The huge V-planes of the Allies now surrounded Mars in a flashing ring, gradually crushing down her stubborn resistance, and we looked forward with eager hope to the approaching end. Then came the stupefying shock of Philadelphia's destruction.

I was in Paris at the time, representing the *New York Century* at the reception to the Commission from Venus. Around the table of honor were gathered the keenest minds of the allied planets. The president of the visiting commission, the Honorable Peros Venasarol, had hardly begun the opening of his address, when the vibrator on my pocket phone signalled. At the moment, the president's daughter, Ava, sat at my side.

In these days, when a journey to another planet is as common as a week-end trip to Japan was in my time, the presence of Venusian women in our social life is accepted as a matter of course; but in 2011 their ethereal glory still held us enthralled, and Ava—Ava was the quintessence of them all.

". . . 'The Bells Are Inside,' Ava Explained."

I was one of the committee appointed to interpret the Earth to the visiting commissioners, but I interpreted it only to Ava. Her presence had called forth in a flash my very soul, and I laid it at her feet with such generous intensity that she accepted it as graciously and as sweetly as a child takes a flower. Ah! that lilt in her voice—the mysterious, fascinating chime of the bells on her wrist—the bells that no one could see—the bells that were to save us from the Martian horror . . . But I am forgetting the reception and the summons of the pocket phone.

With an impatient jerk I drew out the phone, set the silencer so as not to disturb those near me, and adjusted the receiver to my head. Immediately I could hear Ingals, my managing editor. His voice was tremulous with excitement.

"For God's sake, Elvan, hurry back!" he gasped.

"What's up?" I asked.

"I can't tell you—hell's broke loose on Earth!"

"Won't to-morrow do?" I suggested. "The Honorable Peros—"

"Oh, damn the Honorable Peros!" shouted Ingals. "Start now, I tell you." And he shut off with a jerk.

We look upon the present World War with awe because we know it to be the biggest conflict the world ever saw. But Napoleon's wars, Alexander's wars, no doubt were looked upon with exactly the same kind of awe by the then existing humanity, because those wars were the biggest up to those respective times.

What of the future? Suppose the Martians, whose civilization is infinitely older than our own, one day take it upon themselves to conquer the planetarian World, in order to keep their race from extinction, on their dying planet? It's only a step further from the present Hohenzollern idea. For some day the gulf between the planets will surely be bridged. What then? Read this intensely interesting story of the future. We guarantee you will like it.

I glanced around at the assemblage, at the venerable high commissioner, now fully launched forth on his impressive message and, finally, at Ava. An inexplicable fear, vague and uneasy, wound like a cold, thin wisp of steel around my heart. With quick resolve I drew out my notebook to find the index sign of the American Air Service. In another moment I was talking to the manager. There was a night express leaving London, he informed me. Whispering a hasty explanation to Ava, I made my way from the hall up to the roof of the building.

About a dozen planes were lined up on the starting platform and I selected the swiftest looking one of the lot. It was a long, grey Bullet Racer. The aerist, a light-hearted boy still in his teens, assured me he could make the station on time with half his cylinders dead.

Watch in hand, I crept into the asbestos-covered compartment, seated myself by his side and we slid into the night. In a few moments we had cleared the city and were heading straight for London. Instead of following the well-marked route over Calais we took the direct Dieppe path, hoping to gain a few precious seconds by the lessened mileage and the lighter traffic.

For five minutes we breasted the darkness with no sound but the purr of the motor and an occasional click of the altitude lever as the plane rose or dropt to escape the suction holes that our indicator showed us in advance. Then a light flashed out of the black, winking red and white. It was the signal station at Dieppe, floating ten thousand feet above the city. Half the distance was behind us and I had ten minutes left. I turned to my companion with a murmur of satisfaction.

"You'll do it," I said with satisfaction.

"It's easy," grinned the boy. "Last year I pushed a V to Mars. *There's* where the lads move. A hundred a minute with the deflectors off and five hundred when they're on. I'd be there now if they hadn't smashed my back."

I turned with a look of inquiry toward his arched spine.

"Chunk of 'lectrite," he explained. "A grain of it humps you up."

As we sped over the Channel the cloud that covered the sky opened towards the west and I could see Mars glowing dull red, like a baleful eye on the horizon.

"Whatever has happened in America," I thought, "at least, it can't be due to the Martians. Thank Heaven, they are bottled up securely."

My ruminations were suddenly checked as the aerist snapt off his motor and pushed the snub nose of the Bullet at a steep angle towards the earth. We had reached London.

The immense dock of the American Air Service was thronged with excited groups of people. Rumors of an awful cataclysm in America were being stridently discust, and many passengers hesitated to board the *Eagle,* which stood ready on the inclined platform, her black, carbonoid body spotted with even rows of lights from the observation port holes.

One Mercurian had made himself the spokesman for the timorous, and loudly exprest the fears that animated them all.

"Don't tell me it's an earthquake," he was shouting with the volubility and exaggerated gestures that mark the speech of his people. "Whoever heard of earthquakes around Philadelphia? It's the Martians. They've broken loose again."

"Impossible," objected one of his auditors. "The V-planes are hedging Mars so close a fly couldn't get thru."

"That's what they said in twenty-ten," sneered the Mercurian. "Then the electrites began slamming us. I tell you, the Martians have outguest us again. You listen to me—the *Eagle* won't get half way across. Take my advice and stay here."

"If it's the Martians," observed a placid voice in back of me, "they'll hit us here just as quick as over there. I can't see the sense in getting scared off the *Eagle.*"

I turned with a smile of approval to face the speaker. As I suspected from the accent, he was a Jupiterian, huge in bulk and glittering with gold leaf and jewels.

"What has happened?" I asked. "I received a message calling me back to New York, but there were no details."

"There are all kind of rumors. One says Philadelphia is gone. Another tells us all America is wiped off the Earth. Whatever it is, this is no time to stand back in fear. I'm going over."

I fell in with his stride as he turned, and we walked aboard the *Eagle,* whose powerful blades were already slicing the air.

At sunrise the next morning, as the *Eagle* soared across Staten Island, I stood on her dew-wet forward deck and gazed ahead with a peculiar sense of vague fear as to what sight might greet me. I gave a gulp of relief as the outlines of the great city flew rapidly into vision. Before I could dwell any further on the meaning of Ingal's message, the great airship began settling toward her dock.

Without a moment's delay I hurried to the Century Building and soon was winding thru the long lane of writers' desks to the editor's office.

Again a feeling of undefined apprehension chilled me as I opened the door and Ingal's tired eyes met mine. No sleep had closed his—the pupils were pin points in two sunken, blue-grey pools.

"Elvan! Good!" A look of relief lit up his drawn features and he leaned back in his chair. "For the love of glory, Elvan, get over there quick and give us a straight story of this convulsion," he implored. "You're the only one can do it. All the tykes around here have gone insane, I believe. Look what this putty-brained ass says—" He held up one of the scribbled sheets and read from it in a voice ragged with exhaustion: "'No such scene has ever been seen before. The scene beggars description!'"

"Is it as bad as all that?" I asked soberly.

"It's worse," Ingals assured me, becoming grave. "Philadelphia is buried a mile deep and Lord knows who's next."

"Surely, you don't expect—"

"I certainly do. Those vampires of Mars—"

"Mars!" I started in surprise. For the temperamental Mercurian to be seeing Martians behind every catastrophe was quite natural, but Ingals— "How could they?" I protested.

"I don't know. That's what I expect you to find out." His voice rose in grotesque wrathfulness. "Don't stand there theorizing, you blue-headed son of an inkbottle! Get on the job! If I don't soon have something sensible to work on I'll go toppy."

Some ten minutes later I stood on a little height in what had once been Fairmount Park, gazing down on the starkest desolation that the Earth had witnest since Sodom and Gomorrah. Where once five million human beings had lived and loved and joyed and sorrowed, a vast body of sluggish, oily water stretched before the eye. The entire southern part of the city had either sunk or vanished into the air, and the Schuykill and Delaware Rivers, rushing together, had converted the site into an inland sea.

Up towards Germantown and Ogontz, where the land was hilly, the water had not entirely covered the ground and a few heights projected above the surface, barren of any habitation or other sign of life, and showing by their tortured appearance the agony of destruction thru which they had past.

(*Continued on page* 803)

IN THE APRIL "E. E"

The April issue of the ELECTRICAL EXPERIMENTER *will be replete with numerous timely and valuable articles on Electricity, Radio and Chemistry of interest to all readers, both young and old. Don't miss it. It will provide many hours' instructive reading. All the latest advances in Science will be there—as well as fresh news and pictures from the war front. Among the April features scheduled there appear the following:*

"At War with the Invisible"—conclusion of this gripping story of war and science, by R. and J. Winthrop.

"The Phenomena of Electrical Conduction in Gases.—What is Ionization?"—by Rogers D. Rusk, M. A.

"Research and Its Importance to Human Progress."—by Dr. W. R. Whitney of the General Electric Co.'s, Research Laboratory. A special article which every American should read.

"Elcctro-Static Experiments"—Part II—by Frederick Von Lichtenow.

"A new Electro-magnetic Ship's log."

"A marvelous Electrical Tobacco Leaf Sorter" by H. Hartman, C. E.

"How Electricity Changes Modern Stage Scenery Instantaneously"—by George Holmes.

"How Science Takes X-ray Movies of living bodies by the aid of Electricity."

"The Chemistry of Selenium—What Happens in a Selenium Cell"—by Albert W. Wilsdon.

"Experimental Physics"—Lesson 12, by John J. Furia, A. B., M. A.

"Wavemeters—Their Uses and Construction," Part II—by M. W. Sterns.

"The New Electrical Laboratory and Prize Story Contest."

Experimental Physics

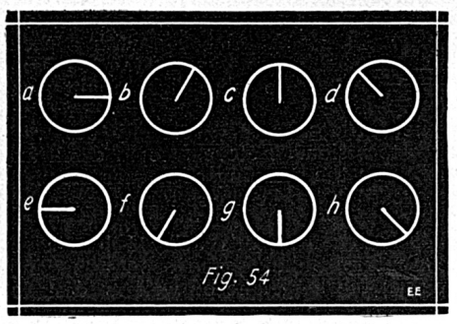
By

JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 11

Photography (Concluded)

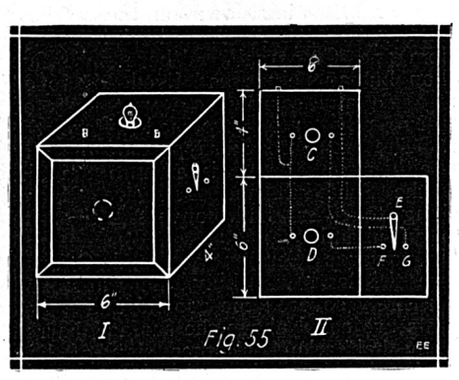
IN lesson 10, the important elements entering into photography from the standpoint of Physics were discust in detail, together with the elements of color theory. Our chief consideration was the *obtaining of the image,* either reduced



Series of Simple Pictures, Which, When Presented to the Eye in Rapid Succession, Give the Effect of a "Moving Picture."

or enlarged as required. In this Lesson, in order to conclude the subject, most of the space will be devoted to the *retaining of the image* even tho this phase of the subject falls chiefly within the realm of Chemistry, rather than Physics. (It should be noted here that because of the close relationship between Chemistry and Physics, one can rarely treat of any topic in one of these subjects without bringing in the other.)

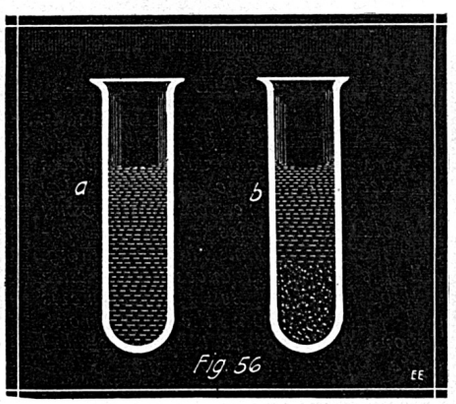
Experiment 61:—When an ignited piece of charcoal is rapidly rotated, we cannot distinguish it, but, however, the appearance of a circle of fire is produced. In a similar manner, rain, tho falling in drops, appears in the air to be a series of liquid threads. This phenomenon is due to the *persistence of vision.* The explanation is that the impression of an object on the retina of the eye remains for some time after the object has been removed or displaced, so that when the speed of the motion is sufficiently great, the object is seen in its new position while its image in the old position is still imprest on the retina. It is this principle of the persistence of vision that makes motion pictures possible. Cut eight squares of heavy manila paper two inches on the side and find the exact center by faintly drawing the diagonals of the square. With these points as centers, draw circles with a radius of one-half inch. On the first, draw heavily its radius in position indicated in figure 54 (a), on the second as in (b), on



Simple Home-Made Duplex Lamp, Handy for Dark Room and Other Purposes.

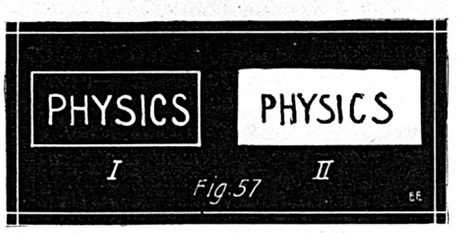
the third as in (c), etc., for all eight discs. If now they are placed one on top of the other and fastened at the left in book form by paper fasteners, on running the leaves quickly with the fingers, (because of the persistence of vision) a *moving picture* of the radius is produced. The moving picture produced on the screen by production thru the complicated machine in the theatre operator's booth is simply enlarged views of the objects in successive series of slightly different positions.

In the ordinary black and white photography most of the operations must be performed in a safe light, red in color (reason to be given later). The following little lamp can be constructed at a very low cost and will give satisfaction in even the most delicate work. A box 6" by 6" by 4" should be made of ¼" wood and the ends joined and glued so as to be light-tight. A grooved frame is made for the front, three parts of which are rigidly fastened together and the fourth tight fitting but not fastened. A piece of window glass can be cut to fit and



Showing the Effect of Light on Silver Bromid (b) After Adding Developer. Solution (a) Not Exposed, Hence Not Changed by Developer.

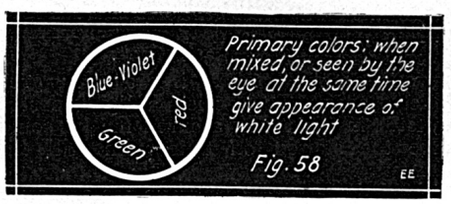
stained, or else a piece of ruby glass can be purchased for a few cents. The fourth part of the frame is not rigidly fastened



This Illustrates the Photographic "Negative" and "Positive." Note That Either Is Negative and the Other Positive.

for convenience in getting at the inside of the box when necessary. In the center of the back (inside) a miniature socket and three volt lamp are attached and a similar socket and lamp on the top (outside). A pair of binding posts are then attached on the top and a two-point switch (consisting of three thumb tacks and a piece of metal) is attached on one side. Connections are made as in figure 55-II (A and B are the binding posts; C and D, the lamps and E, F, G, the three point switch). To make a real good job of it the inside of the lamp can be enameled white and the outside stained and varnished. This little lamp can now be used both for "dark room" and other purposes. Two dry cells are required to run it. Turning switch to F gives red light and turning to G gives white light.

Experiment 62:—The retaining of the image after it is formed falls entirely in the field of Chemistry and is based on the principle that chemical action is often caused by light. For example, the fading of dyes is caused by the chemical action induced by light. The formation of starch



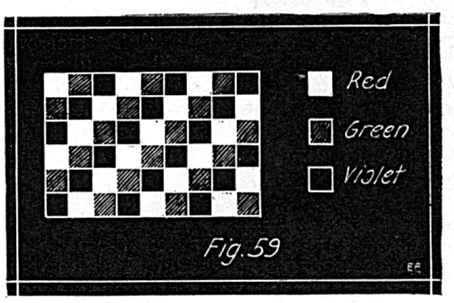
When the Colors Indicated Are Mixed, by Rapid Rotation, the Effect of "White Light" Is Produced.

from the elements in water and from carbon dioxid which is breathed out by human beings, occurs in the leaves of plants only under the influence of sunlight, so we see that the most important of all chemical actions (since life depends upon it) is caused by light. If equal volumes of ferric chlorid and oxalic acid* are mixed in the safe red light of the "dark room" and then an equal volume of potassium ferricyanid added, the color changes but slightly. If, however, this same process is carried out in daylight the result is a pronounced blue color. The ferric chlorid and oxalic acid when mixed in the dark or safe red light do not react, but when mixed in daylight do react and form another compound-ferrous chlorid; whereas ferric chlorid on being mixed with potassium ferricyanid does not react, ferrous chlorid does, and the result is the compound called "Turnbull's blue." This illustrates the process of *blueprinting.* The blue-print paper is coated with a compound similar to those mentioned above (according to the manufacturer) and when light strikes it a chemical change results. On washing with water where light struck the paper it changes to Turnbull's blue, and the unchanged material is washed away.

Experiment 63:—(To be performed in dark room.) Take equal amounts of silver bromid solution in two test tubes, (see Fig. 56). Make sure that none but the safe "red light" strikes the first test tube (a) and expose test tube (b) to white light.

* Solutions of these chemicals are to be used.

(*Continued on page* 799)



This Highly Magnified View of Plate Used for Color Photography Shows Probable Arrangement of the Colored Starch Grains.

Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of the ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

An Exceptional Amateur Radio Station

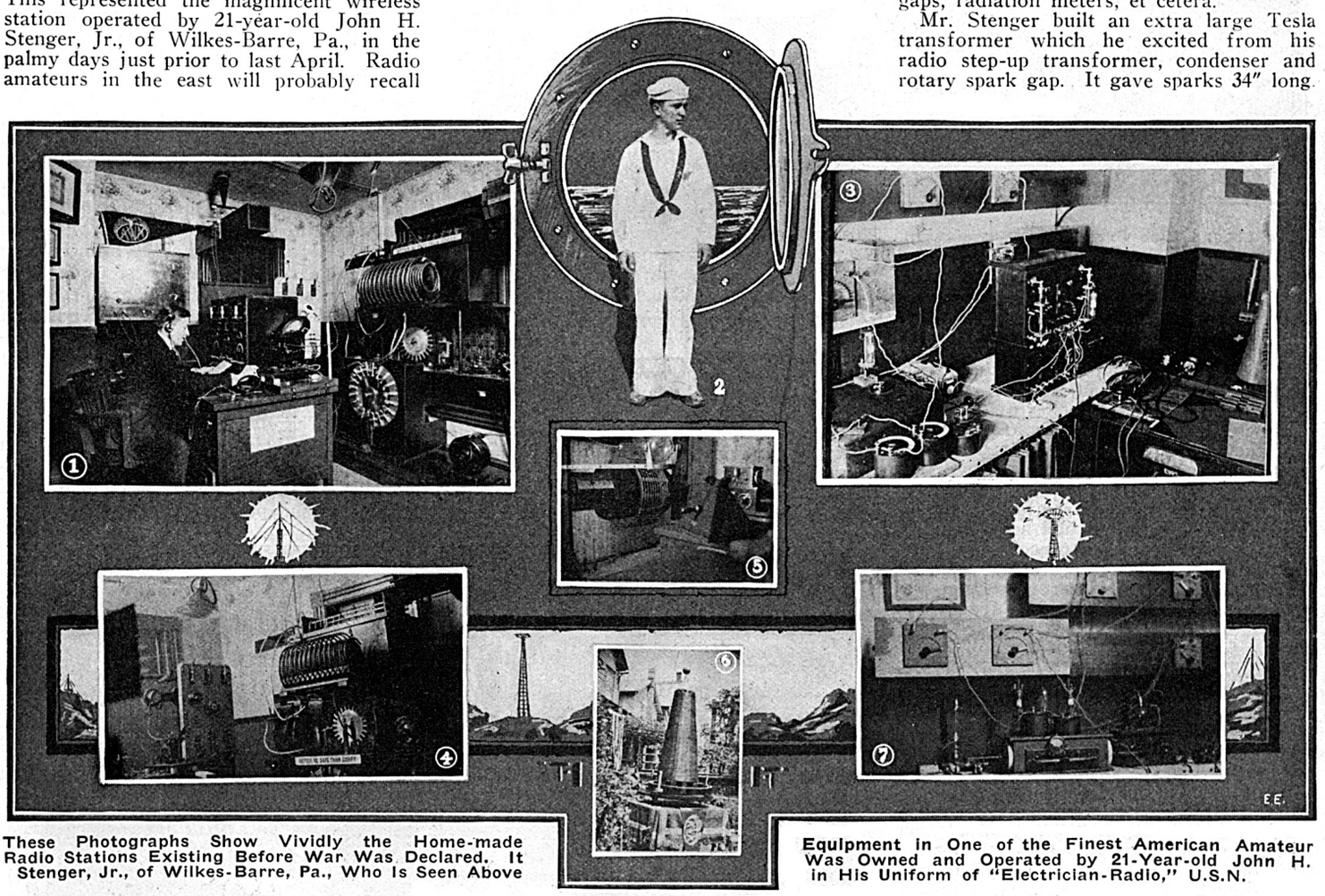
WAR is War—we all know that. But look at the accompanying set of photos showing some of the glories of amateur radio days before the war. This represented the magnificent wireless station operated by 21-year-old John H. Stenger, Jr., of Wilkes-Barre, Pa., in the palmy days just prior to last April. Radio amateurs in the east will probably recall the station who used to answer to 8.Z.S. The station was dismantled April 12, 1917, in obedience to the President's proclamation. Its operator, John H. Stenger, Jr., enlisted in the U. S. Navy May 1, 1917, as landsman, electrician-radio. He is now at the U. S. Submarine Base, New London, Conn., as Electrician-Radio, U. S. N. His photo in uniform is shown herewith.

Youthful Mr. Stenger has done the "big thing"—enlisted where his services can be of the highest value to his country. We present the accompanying photographs thru the courtesy of his father—a co-partner in the enjoyments formerly afforded by this excellently equipt radio laboratory. There were many such stations thruout the country that ambitious and ingenious American boys had perfected and built. Here is where the "ideas" were evolved—and now the country benefits.

Look at the details of this particularly high grade experimental wireless station here illustrated. It was fitted out in true professional style. The transmitting plant was a beautiful and efficient piece of work, including as it did a 1½ K.W. transformer, oil condenser, interchangeable rotary spark gaps, radiation meters, et cetera.

Mr. Stenger built an extra large Tesla transformer which he excited from his radio step-up transformer, condenser and rotary spark gap. It gave sparks 34" long. H. F. X-Ray equipment was also on hand.

The receiving equipment comprised a 2 step tubular Audion amplifier, experimental apparatus, etc. The antenna was a large affair and very well built. It was supported by a 40 ft. chestnut pole, surmounted by a 60 ft. steel tube, giving 100 ft. elevation. The aerial contained 10 wires, spaced 2 ft. apart, and measured 91 ft. long, spreader to spreader.



These Photographs Show Vividly the Home-made Radio Stations Existing Before War Was Declared. It Was Owned and Operated by 21-Year-old John H. Stenger, Jr., of Wilkes-Barre, Pa., Who Is Seen Above in His Uniform of "Electrician-Radio," U.S.N.

WIRELESS STATION IN FRENCH TRENCH.

The present illustration shows a radio station and the operator standing outside the dugout in a French, second line trench.

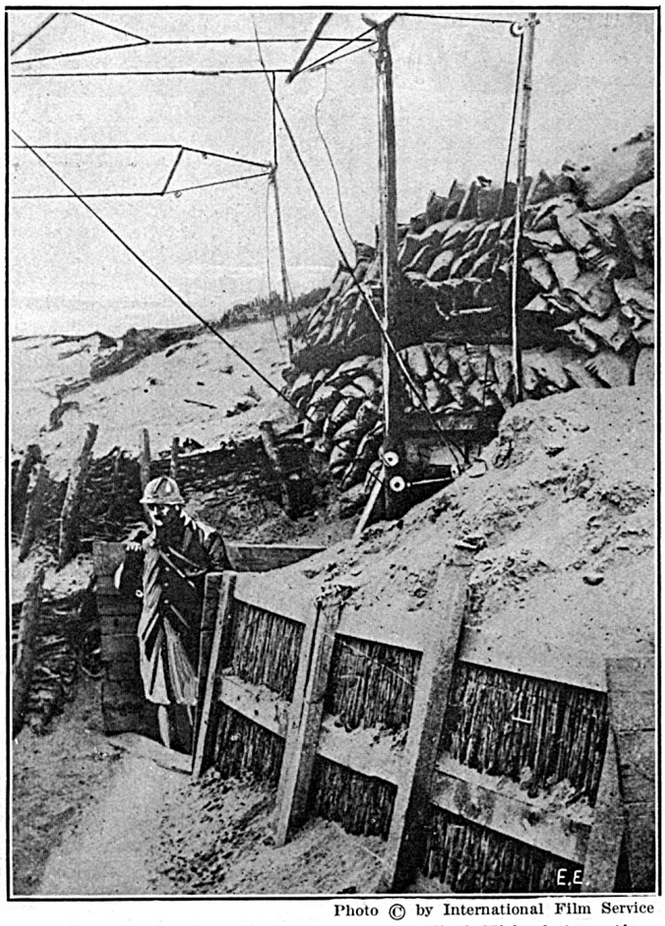


Photo © by International Film Service

In a Second Line French Trench We Find This Interesting, Battle-Front Radio Station. The Aerial is a Low Affair, so as Not to Be Easily Seen by the Enemy. The Apparatus Is Placed in the Dug-out at the Right.

These men are almost continually under bombardment the enemy making every effort to destroy the stations and the aerials. The aerials extend but a short distance above the top of the trenches of course, as becomes clear from the photo, as otherwise they would soon be destroyed by shell or machine gun fire from the enemy. The radio apparatus is located in the dug-out shown; note the heavily reinforced roof of sand bags to withstand shell fire. Some of these dug-outs form entrances only to an elaborate underground operating room or gallery. This gives better protection and less interference due to noises from shell and rifle fire.

DECEMBER MEETING OF THE I. R. E.

A very interesting paper was presented at the December meeting of the Institute of Radio Engineers at the Engineering Societies Building, New York, on December 5th.

Many notable radio men were on hand and the attendance was large, mostly due to the fact that the paper had a good advance notice and the interesting topic of "Radio-telephony on the Union Pacific Railroad" was discust. Dr. Frederick H. Millener, the author, described with many amusing incidents the work of almost ten years spent in experimenting and installing wireless telegraph and telephone sets on moving trains and in main stations.

The first researches were made on a specially constructed flat car, about ten feet in length, and weighing a couple of tons, fitted with storage cells and other apparatus. On each of the cars were set two short poles and a crude four wire aerial was strung between them. An illustrated slide was here shown and the crowd of curiosity seekers about the radio-car almost swamped the small car and its operators. This car was kept in the yards and experiments were made from the laboratory located in a small shop nearby. It was possible to sound various kinds of warnings on the car and to start, stop and reverse its motion by Radio. An arrangement was also worked out so that a tower man could send a signal and an automatic arm or light would operate and warn the engineer in the cab. But this nearly always failed to work at a critical moment and not the some few thousand times in succession that is required of a device which is to be practically adopted.

At this juncture in the game certain patent suits started, claiming infringements, and therefore the work was abandoned for a time, also certain needed apportionments didn't quite materialize in the budget.

After a time work was again resumed and better quarters were fitted up and a number of stations erected along the main line of railroad; these maintained direct connection constantly. Work was also done in Radio-telephony and a number of arcs of different types were experimented with. Also some were tried with gases contained in the surrounding chamber; a disastrous attempt at using illuminating gas put the gas idea out of the running.

The Radio-phone worked fairly well between the establisht land stations but some difficulty was experienced with the set installed on the train. The voice had a peculiar manner of dying away suddenly and then after a time coming back again.

It was also tried in conjunction with the then existing telegraph lines, using the same as aerials, but it did not answer very satisfactory and this scheme was dropt.

Later a regular research laboratory was establisht on wheels, being in the same class as the safety and other exhibition cars. A pullman dining car was made over and a large aeriel set a few feet above the roof. Also at one end a collapsible mast capable of extending about 80 feet was fastened for experiments on sidings. A large generator and a gasoline engine were installed to furnish power. One end was partitioned off for sleeping quarters. The rest of the car was devoted to the experimental laboratory and judging by the lantern slide shown of it, it was some class! With carpet on the floor, rest chairs and what not—well it certainly looked more like a grand salon!

Nevertheless much important work was accomplisht, and exhaustive tests were made and charts calibrated of results. The ten years of experimenting fell thru when war was declared and the laboratory hung out its shingle, "closed for the season!" The paper was a change from some of the technical papers that have been read and Dr. Millener's personality did much to get the "high-brows" in the audience in good spirits and all of those present appreciated his coming East to speak before the Institute on so interesting a topic.

TEACHING U. S. AVIATORS RADIO-TELEGRAPHY.

"Learn to do by doing" is the motto of Uncle Sam's new military aviation service. And let no one tell you that action is not suited to the instruction. One of the first things new recruits have to do is to learn wireless telegraphy. Mark the application of their motto: They learn the art by talking across tables with one another by wireless. Here is a class in action. An airman's first step in learning the science of radio, which he will shortly be called upon to use over the German trenches in France, is to master the International Morse Code. The men here shown are cadets at one of the "Ground Schools" practising the sending of dots and dashes, which are immediately reproduced on the tape before them. This permits them to lengthen or shorten their motions until they are wholly accurate. The teaching of Radio to the thousands of new aviators now being schooled by Uncle Sam is a man's-size job. Radio instructor officers have been recruited from civilian walks of life for this purpose, in many cases.

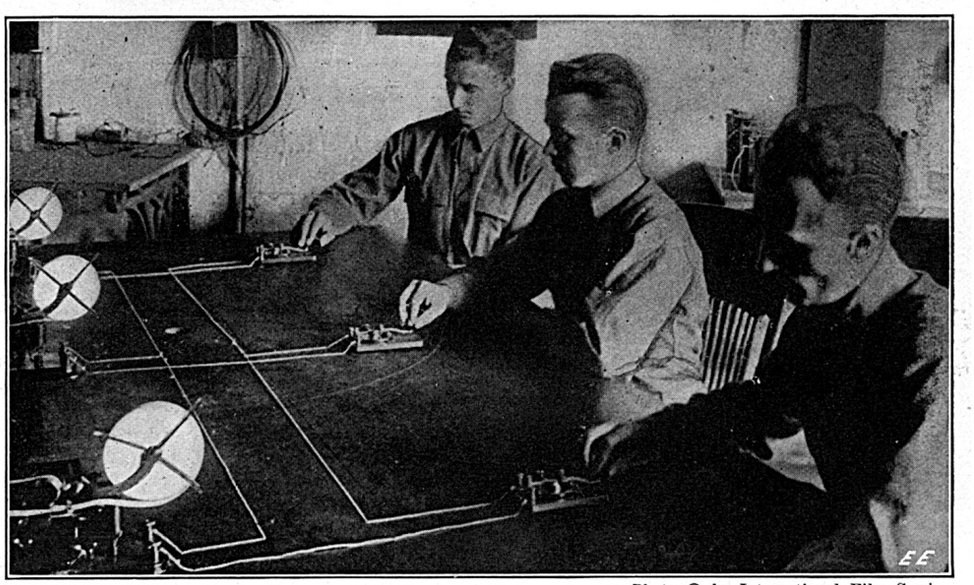


Photo © by International Film Service

How Uncle Sam's Aerial Fighters Learn Radio. They Practise the Dots and Dashes at First, the Signals Being Reproduced Before Them on the Tape Registers. This Allows Them to Check Up Their "Sending Fist."

Visiting Arlington via the Talo Club

By W. J. HOWELL

IT all happened along about the time that "Arlington" was first put into operating condition, that the members of the Talo Club got the idea that they wanted to visit the place and see for themselves just what really was down there that made so much noise in the 'phones at ten P. M. every night. To think was to act, and it was found that one of the Eastern trunk lines was running excursion trains down to Washington and back to New York, thereby giving about ten hours in the Capitol to see the sights while the cost would be in the "Amateur" limits of money, which in this case was three cold dollars.

There were four of us who went, and a slight mention of each one will not be amiss. "Woody" was the big guy who had the reputation for wearing sand-paper collars, in other words, a roughneck, while "Mac" was an expert brass polisher at one of our leading hotels. Then there was "Dickey," the *Secretary* of the outfit, and myself, who unfortunately had to hold down the job of *President,* because none of the bunch wanted the honor and they had to have some one to blame if things went wrong.

Well, it was decided to beat it to Washington and that we meet at the station and take the mid-night train, arriving there about six A.M., Sunday morning. Of course, we all brought something to eat, but "Mac" was the winner of the first prize, for he came with sandwiches made of slices an inch thick, and butter enough to feed one at the present "Hooverized" rate for an indefinite period. The ham was in the same class, and upon our requests he mentioned that the food supply was gotten by talking to the cook and appropriating a little at a time. What he talked about we couldn't find out, and it must have been exceedingly interesting, but at any rate, we helped "Mac" to eat what he had and saved ours. I brought some steamed chestnuts, but the jokes that were pulled off were enough without having to eat them besides.

'Long about this time the train started, but not before a meeting had been called to order and more work done then in a short time than we ever did formerly, but the idea that we were starting broke up this business stunt and we tried to get as little sleep as possible while passing thru Trenton, West Philadelphia, Wilmington, Baltimore and other small towns along the right of way. About five A.M. "Dickey" and I took a little trip thru the train, and as we were in the second car, and the outfit consisted of ten coaches, we had a good chance to see the human animal at sleep, for believe me, the shapes that people can get into when sleeping in day coaches makes one wonder if their hair hurts when they bend it!

We ended up at last on the back platform and watched the sun break thru the southern "ether" and it was needed in its thermal form because it was rather cold down there in November. Daylight at last came in all its glory and made me think that the sun-dodgers of our town miss something when they sit up until all hours listening to radio signals and then turn in just as it gets light. Washington very shortly was reached and we piled off.

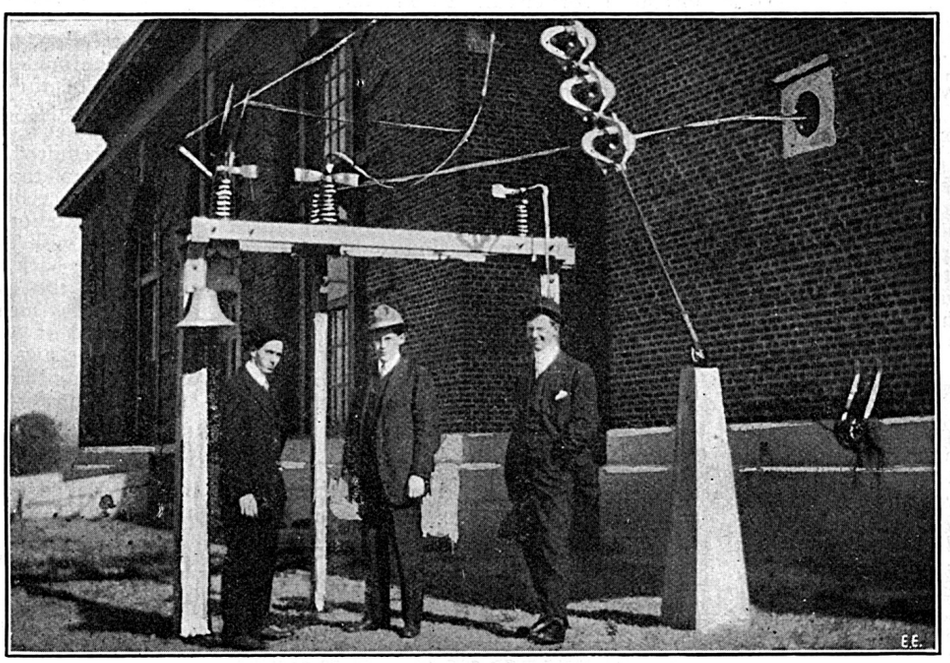
After washing off the "real-estate" of five states and one district, we started out and kept our eyes open for a place to fill up our insides, and believe me, we felt in the need of something after walking, for Washington apparently got a divorce from itself, because one has to walk a long time to even cross the street. During this time we had about twenty fellows with all kinds of automobiles ask us to allow them to show us Washington for the mere sum of a dollar a piece, but there being four of us and Audions about the same price, we decided not to indulge. At last after much hunting we discovered Bryant's Lunch Room about four blocks from the Capitol building and stopped there to eat, but we often look back and wonder if Bryant was in the food business at the time. Breakfast being finished we got under way and looked over the Government buildings there-about, but the aerial on the Bureau of Standards attracted first attention while off in the distance could be seen the Washington Monument and the Towers of Arlington.

Passing on down the avenue we came to 14½ street, and while we found the street all right we couldn't locate the *half,* so we curbed our interest on that pavement and wandered on looking for a car that "Mac" said would take us to Arlington.

Well, we walked and walked some more and still no car, but our trip took us past the Monument which was not open for business, altho it was an early riser and was up when we got there. Looking at the top gave us a permanent bend in the back of the neck and was good training, for we sure needed aid in finding the top of the Radio Towers later on. Walking on from there about a mile, led us to where a car was waiting to make the trip to Arlington, and we piled on.

Passing over the Potomac River and into Virginia, was a short trip, but we nearly killed. "Mac" because the car went right past the Monument, and while there we had asked "Mac" if it was the one we were looking for and, of course, he said no, thereby making us use some more leg power in order to find it. Pretty soon the conductor yells out *"Radio,"* and we found ourselves jumping off at a little two-by-four wooden shack with a sign that stated that this particular spot was what is known in the amateur world as "Radio, Va."

Crossing the track a path led us down into a small depression, thru which past a stream of water which kept the *grounding system* moist, but at the time of our visit we found that when crossing the little foot bridge the stream tried to moisten the footal supports of the party, besides keeping the buried copper wires in working condition. At the top of the slight rise was the radio station, and altho we had seen it before crossing the track and had taken pictures of it, the bunch took some more, for it certainly was worth all the trouble of getting to Washington just to look at those towers. Pictures that have been publisht do not show the spectator the real thing and make him feel that his own little aerial at home is a mere bird cage compared to the one before his eyes.



". . . . . Going Outside to Watch the Antenna 'Spark,' Which it Didn't, We Found the Famous Aerial Switch, Mounted on Two Short Poles With a Ship's Bell Attached. Guess They Ring the Bell When Signals Come Down the Lead-in." Author is Central Figure in Photo.

Climbing upward we came to the main building and walked boldly in all the while expecting some one to throw us bodily out, but nothing happened, so we gathered courage and started to inspect the plant. Fortunately "Mac" had been down before, and while there, took some pictures and became pretty well acquainted with one of the operators. In the mean time, he had had the pictures enlarged and brought them along, all of which made things somewhat easier for us because, as I look back, I don't think that we would have been allowed to wander over the place just as we did, without being told to beat it. That is, unless we could have managed to scrape up acquaintance by trying a little of that "mental telepathy" stuff. It works—sometimes.

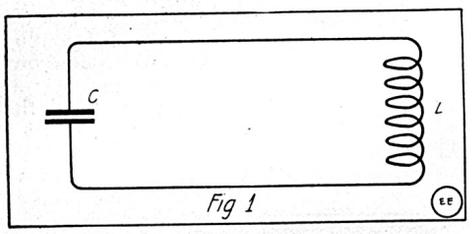
The main transmitting room at that time contained the large 100 K.W. set and a small arc outfit, besides a regular 5 K.W. set for ship work only. The "receiving room" was in the next building, and was built like an icebox with walls two foot thick. The two buildings stood about three feet apart so that no sound of the transmitting set would reach the operator in the receptor room. Two men are always on duty, one in the transmitting room and one in the "listening box," and when the fellow hears a station calling him, he signals to the fellow outside, and he in turn starts up the 5 K.W. set and stops it when signaled. A relay is used so that no high voltage wires pass

(*Continued on page* 800)

The Design and Use of the Wave-Meter

Part I—By MORTON W. STERNS

THE Wave-meter is an instrument used to measure and detect the length, frequency, and amplitude of emitted oscillations. Essentially it consists of an inductance connected in series with a condenser, either or both of which may be variable. For standard



The Simplest Form of Oscillating Circuit, Comprising a Capacity "C" and an Inductance "L," Connected in Series. The Basic Circuit of the Wave-Meter.

wave-meters of great precision the oscillation constant $\sqrt{LC}$ is generally kept constant in order that the decrement of the instrument shall remain constant over its entire range. This is done by making both the inductance and capacity variable, i.e., by fastening a variometer to the condenser shaft. The type of wave-meter generally in use at present is the variable capacity type, having numerous coils for a great range. Formerly, the wave-meter having a fixt capacity and variable inductance was much used.

It is generally conceded that the Wave-meter is the most valuable instrument in a Radio Laboratory as it can be used for:—

1.—*Measurement of wave-length. (Transmitted or received.)*
2.—*Measurement of decrement.*
3.—*Measurement of inductance.*
4.—*Measurement of capacity.*
5.—*Making resonance curves.*
6.—*Making various antenna measurements.*
7.—*An exciter emitting waves of predetermined length.*
8.—*Measurement of mutual inductance.*
9.—*Measurement of the coefficient of coupling.*
10.—*Measurement of the distributed capacity and natural period of coils.*

These various applications of the wave-meter will be taken up in due course.

Having imprest upon the reader the importance of the wave-meter, its great adaptibility and various uses, we will now undertake a general review of a few elementary principles in order to make the paper intelligible to the great number of young men just taking up the subject of Radio at the various schools of the Army and Navy, as well as radio students in general.

Realizing the breadth of the field to be covered in the space available and the necessity of keeping the paper very elementary, it is to be expected that certain topics may be neglected.

Figure 1 represents a simple circuit consisting of an inductance and a capacity connected in series. If the condenser is charged to a given potential and then allowed to discharge thru the inductance, oscillations will be produced whose frequency will depend upon the value of the inductance L, and the capacity C.

Let us now consider this simple proposition with respect to a Radio Transmitter as shown in Fig. 2.

Suppose the condenser C is connected to some source of high voltage alternating current, such as the secondary of a step-up transformer. When the potential of the condenser rises to a value sufficient to break down the gap G, the condenser will discharge across the gap and set up oscillations in circuit 1, of a frequency depending on the values of L and C.

If now another circuit L'C', consisting of an antenna having a capacity C' with respect to the earth, and an inductance of a value L', is brought near circuit 1 (i. e., coupled to it) energy will be transferred from the first circuit to the second circuit by pure transformer action. If the values of L'C' are adjusted so as to give circuit 2 the *same frequency* as circuit 1, then (ignoring gap action and coupling) the greatest amount of energy is transferred from circuit 1 to circuit 2, and an ammeter placed in the ground lead of circuit 2 will register the maximum current or circuit 2 is said to be in *resonance* with circuit 1.

The last paragraph demonstrates clearly the principle of resonance on which all wave-meters and decremeters work.

We will now proceed to show how the values of inductance and capacity affect the frequency of the oscillations in a circuit, and how, knowing any two of the three factors (wave-length, inductance, or capacity) the other can be found.

The wave-length (λ) multiplied by the number of waves per second (n) must equal the velocity of propagation (V).

$$\text{or } V = n\lambda \quad (1)$$

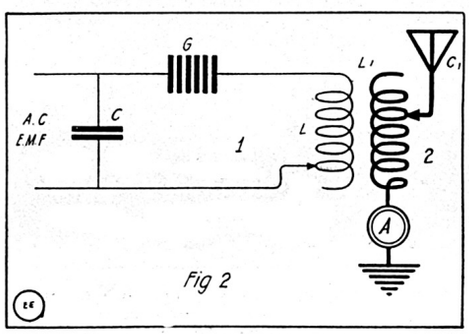


Diagram Showing How Maximum Current is Developed in An Inductive Circuit—C 1, 2, A—When Such a Circuit is Tuned to "Resonance" With an Exciting Circuit—C, G. L.

Where V is the velocity of propagation of radio waves (the speed of light) 300,000,000 meters per second.

$$n = \frac{1}{2\pi\sqrt{LC}} \quad (2)$$

expressing L in henrys and C in farads.

Equation (2) can be found in any text book on Alternating Current.

Substituting in Equation (2) the constants necessary to change L to centimeters and C to micro-farads we have:

$$N = \frac{5.033 \times 10^6}{\sqrt{L_{cm}\ C_{mf}}}$$

Putting the value of n back in equation (1) we have:

$$300{,}000{,}000 = \frac{5.033 \times 10^6}{\sqrt{L_{cm}\ C_{mf}}}\ \lambda$$

$$\text{or } \lambda \text{ meters} = 59.6\ \sqrt{L_{cm}\ C_{mf}} \quad \ldots\ldots (3)$$

Equation (3) is known as the fundamental equation of radio and much use will be made of it in further papers.

Oscillations taking place in a circuit (or emitted waves) can be of two kinds, damped or undamped.

Fig. 3 represents a damped wave discharge of the limit allowed by law (logarithmic decrement 0.2) which require 24 complete oscillations before the amplitude of the last oscillation is reduced to one per cent of the first. It is discharges of this type that are in use the most at present. They are produced by quenched and rotary gaps, etc. Waves of this type are received on ordinary receivers using crystal, plain Audion receptors, etc.

Undamped waves are represented by Fig. 4. Here we see that there is no damping or decay between successive alternations but that they remain of a constant amplitude.

Waves of this type are coming more and more into use, especially for long distance communication. As can be seen they represent a continuous flow of energy and are produced by the arc, Oscillion, radio frequency generator and other means. In receiving these waves a special type of receiver is required, embodying either a tikker to break up the waves, or a separately variable source of oscillations (such as the oscillating Audion) to "heterodyne" or produce beats with the incoming waves.

Referring back to Figure 3, we shall consider what the *Logarithmic Decrement* is and how it is measured. Each wave train is composed of oscillations which are supposed to die away so that the ratio of any oscillation to the one preceding it is constant, as the ratio of A^1 to A.

This constant ratio is known as the damping of the circuit and the Naperian logarithm of one oscillation to the one preceding it is called the *Logarithmic Decrement* of the circuit.

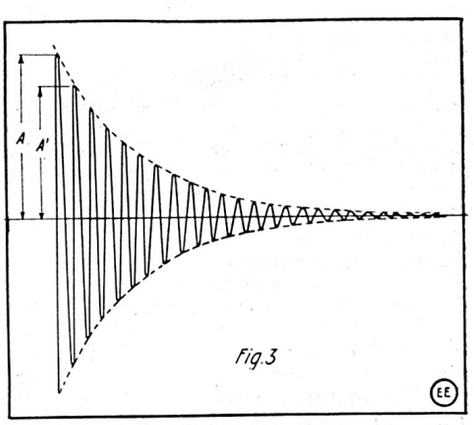
Exprest mathematically $\delta = \log_e \frac{A}{A_1}$

Where δ = Logarithmic Decrement
and e = base of Naperian Logarithms (2.71828).

The logarithmic decrement determines to a great extent the broadness of tuning and the amount of interference produced. Hence the U. S. Government's limit that no transmitter shall produce waves having a greater logarithmic decrement than .2.

An instrument whose purpose is to measure the logarithmic decrement of a circuit is known as a decremeter, which is nothing more than a wave-meter with an indicating instrument in circuit to indicate current ratios. More will be said about the decremeter and its uses in the following installments.

Suppose now we are to design a wave-meter having a range of from 200 to 3,000



Principle of the "Logarithmic Decrement"—Each Wave Train Decays in the Manner Shown, so That the Ratio of Any Oscillation to the One Preceding It is Constant, as the Ratio of A^1 to A.

meters, with 20% overlap between coils, and so designed as to give small distributed capacity, low internal decrement, etc.

The first thing to decide upon is the condenser; this is generally designed so as to give a variation of six times its minimum capacity. By this I mean that the capacity at 175° on the condenser should be six times the capacity at 10° on the condenser.

We use this value because, as shown by the curve in Fig. 5, the variation of more than six times the minimum capacity of the condenser does not vary the wave-length as rapidly as the addition of a new coil.

The condensers used in commercial wave-meters vary from .0015mf. to .008mf., but .003mf. is generally used.

The wave-meter is seldom calibrated below 10° or above 175° because the per cent capacity change per degree is so small that the tuning becomes too sharp for accurate work.

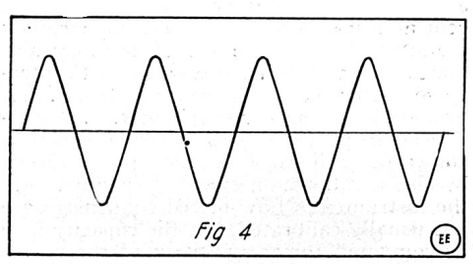
In designing our wave-meter let us assume a capacity of .0005mf. at 10° and .003 mf. at 175° and make our inductance coils conform to these limits.

We will now consider the coils which will be made of the pancake type, wound with *litzendraht* (insulated stranded cable, each wire being insulated) and *banked* by layers. These exploring coils will be connected to the meter by a flexible 3½ ft. leather covered cord.

The lower limit of the meter is 200 meters and this is at .0005mf.

$$\lambda = 59.6\sqrt{LC} \quad \text{equation (3)}$$

Where L is the inductance in cm. and C



Illustrating the Principle of the "Undamped Wave" as Used in Radio-Telegraphy and Telephony. There is no Damping or Decay Between Successive Alternations.

is the capacity in microfarads to give a wave-length λ. $\lambda^2 = 3550\,LC$.

$$L = \frac{\lambda^2}{3550\,C}$$

$$L = \frac{40{,}000}{3550 \times .0005} = 22{,}500 \text{ cm.}$$

At the upper limit where C = .003mf. and L = 22,500 cm.

$$\lambda = 59.6\sqrt{22500 \times .003} = 490$$

Now to allow an overlap of 20%, the minimum wave-length of coil No. 2 must equal 80% of the maximum of coil No. 1.

$\lambda = .80 \times 490 = 392$ meters at .0005mf. capacity. Therefore:

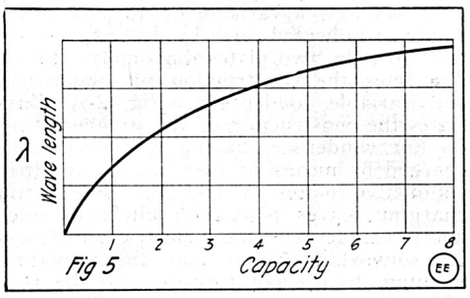
$$L = \frac{(392)^2}{3550 \times .0005} = 86{,}400 \text{ cm.}$$

$$\lambda \text{ max.} = 59.6\sqrt{86{,}400 \times .003} = 960 \text{ meters.}$$

Following this method we find we need four coils which are tabulated below, showing the individual inductances and range of wave lengths.

Coil No.	Inductance in cms.	Wave Length Range
1	22,500	200—490 meters
2	86,400	392—960 "
3	338,000	774—1900 "
4	1,310,000	1520—3740 "

It is, of course, understood that the reason we have the high upper range is because the four coils are necessary to reach 3,000 meters and the upper range of the fourth coil is 3,740 meters. This is generally not objectionable, but in case it is, it simply necessitates the selection of a different capacity variable condenser.



Graph Illustrating the Reason For Using a Wave-Meter Condenser Which Gives a Variation of Six Times Its Minimum Capacity.

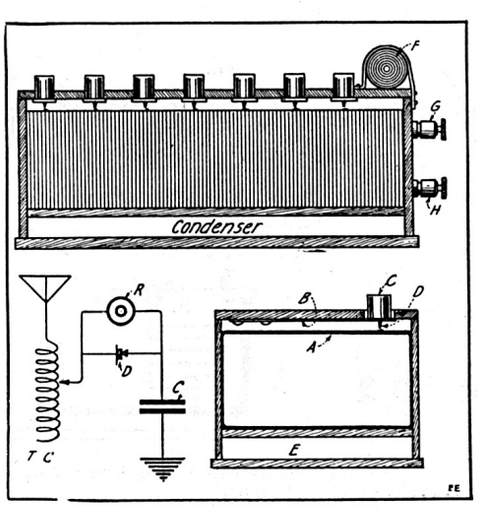
The next step will be to determine the size *litzendraht* to be used and this is largely a matter of experience and keeping the meter decrement low (3x16x38 litzendraht is much used). Next a standard mean diameter is selected so that the bobbins of all the coils are the same size; and using Perry's Formula the number of turns are easily calculated.

(To be continued)

"SECRET SERVICE" POCKET RADIO RECEPTOR.

This is a "real" pocket receiving set, one that actually receives while you are out on the street or any other place. The set consists of a special tuner, condenser, detector, 'phone and an "invisible" aerial. The tuner is 4 inches long, 2½ inches deep and 1½ inches wide. As shown in the illustration, A is the wire of the tuner, B is a strip of spring brass, C is a knob of brass soldered to the spring strip, D is a needle point (not steel) soldered to the spring strip, E is the condenser (fixt), F is a detector made of a blown-out cartridge fuse as described in the April, 1917, number of the ELECTRICAL EXPERIMENTER. All the spring strips B are connected to binding-post G by means of a wire. One end of the wire on the coil is connected to binding-post H. Selectivity is obtained on this tuner by pressing the buttons C.

The aerial is composed of a long flexible wire sewed in a zig-zag way in the back of a coat and insulated by empire cloth.



A de Luxe Pocket Radio Set For Secret Service and Like Work. Rapid Tuning is Accomplisht by Pushing on the Various Contact Buttons—One at a Time.

A ground is obtained by running a flexible wire thru the trousers to a brass heel plate.

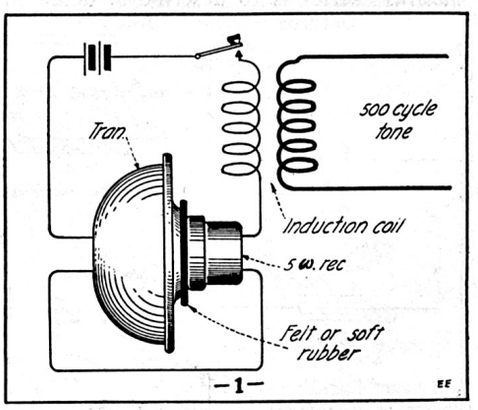
In operation the tuner is held in the coat pocket. By pressing the buttons of the tuner, messages are received in the dots and dashes corresponding to the radio-telegraphic code.

Contributed by HARRY E. FUCHS.

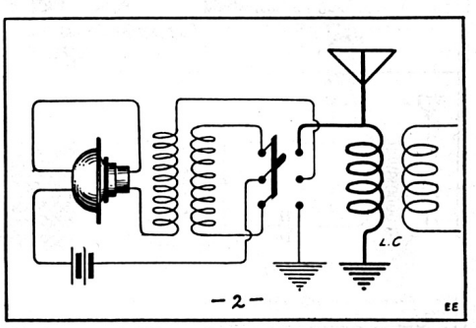
HY-TONE TESTER FOR MINERALS AND CODE PRACTISE.

Being a steady reader of your paper for nearly two years, I thought I would send you in a little stunt which I have been using and found very reliable and satisfactory. It is a high frequency tone device for testing sensitive spots on crystal detectors and wired up as shown in attached sketch. By building up the felt pad, any range from about 300 to 1,000 cycles per second can be obtained, and it produces a pure musical tone of constant amplitude and strength, with no scratching or frying noises whatever. There are no adjustments to make or anything to get out of order.

A five ohm telephone receiver is used as it takes less battery, operating on from two to three dry cells. A regular 75 ohm receiver can be used, but this will require more battery, from 6 to 8 cells. This also makes an excellent wireless practise set. I wired it into my set with a small three-pole knife switch as shown, but almost any hook-up will do. In connecting up the battery, however, it will only operate with the current in one direction, or the current must flow to build up the permanent magnetism of the receiver and not neutralize. Am sending you this idea for I know it works perfectly, with no trouble or bother whatever.



Clever Form of "Microphone Howler" For Radio Tests or Code Practise Work. It Gives a Pure Note of From 300 to 1,000 Cycles, Depending Upon the Distance Between Microphone and Receiver.



Hook-up of Microphone Howler to Primary of Loose Coupler "LC," So That Tuning May Be Practised in Natural Manner.

Contributed by CURTIS KISSELL.

RADIO CLUB OF AMERICA NEWS.

The Radio Club of America held a meeting at Columbia University on October 27, 1917. Two important papers were read, namely, "Thermo Couples in Electrical Measuring Instruments" and "Radio Frequency Instruments" by Dr. H. O. Taylor and Mr. Charles G. Kahant, respectively.

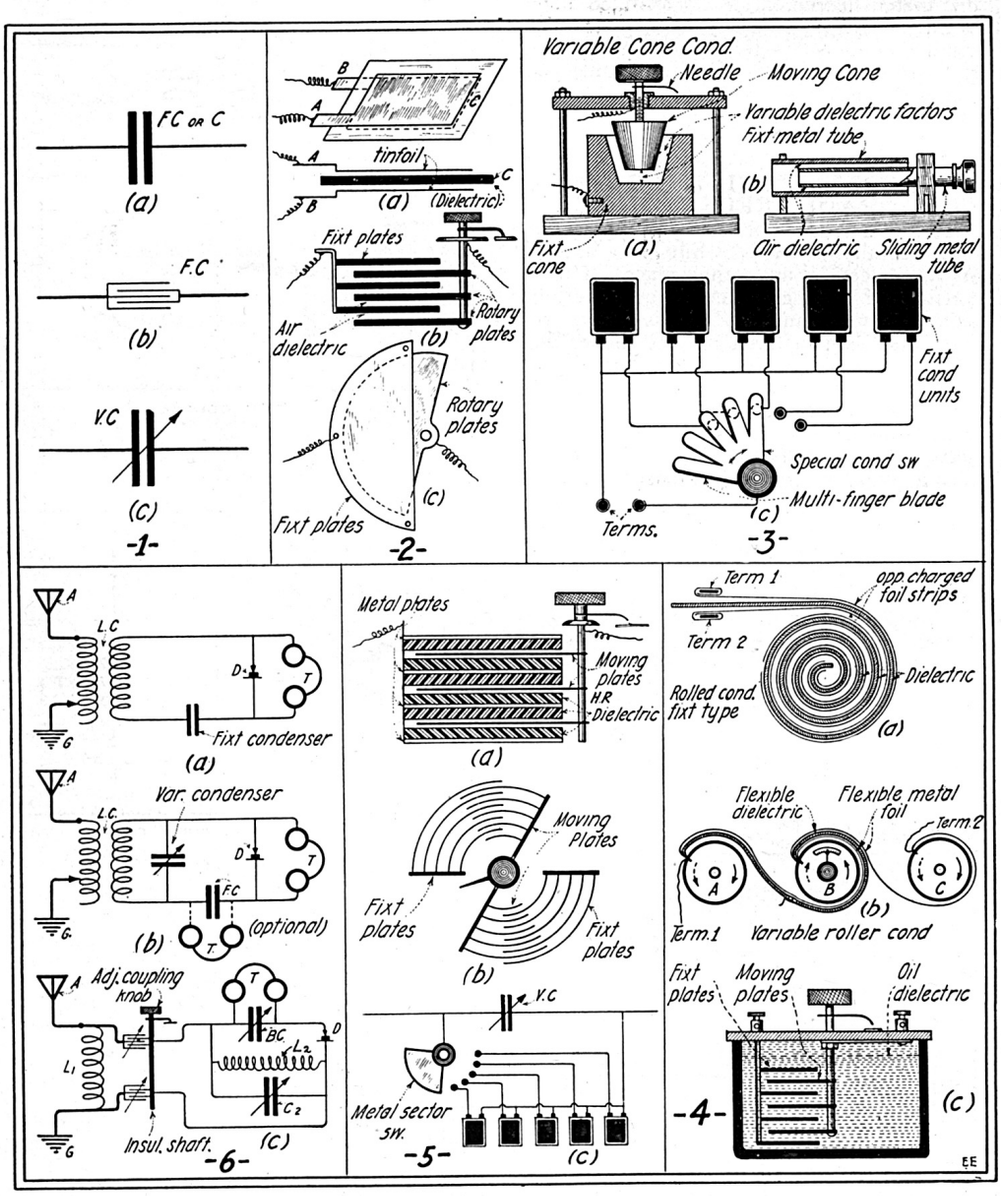
The How and Why of Radio Apparatus

By H. WINFIELD SECOR, Assoc. I. R. E.

No. 7—Radio Receiving Condensers.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations, that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the seventh paper is RADIO RECEIVING CONDENSERS.

PRACTICALLY all modern radio receiving sets employ some form of condenser or capacity, either in the form of a definite fixt capacity or else in the form of a variable or adjustable capacity. The aim of this installment of the *"How and Why of Radio Apparatus"* series is to describe in detail the principal types of condensers found in modern radio receiving apparatus, as well as their use and connection in these circuits.



The Principal Types of Radio Receiving Condensers Are Here Illustrated and Their Action and Use Described for the Benefit of the Student.

Referring to the diagrams herewith, Fig. 1 shows how fixt and variable condensers are represented in diagrams and hook-ups of radio receiving apparatus; Fig. 1-A showing a fixt condenser and B, a second way of representing a fixt condenser, while C shows how a variable or adjustable capacity is indicated, viz., by drawing an arrow thru the two plates diagonally. Fig. 2 illustrates the construction of simple fixt and variable condensers. Fig. 2-A illustrates the construction of the simplest form of fixt condenser, having a dielectric C, charged by means of two tin-foil or other conductive plates A and B. The metal charging leaves placed on alternate sides and in contact with the dielectric are always cut somewhat smaller than the insulating medium, to prevent leakage, and the possible chance of short-circuits. The small fixt condensers found in a great many radio receiving sets are made up of from ten to fifteen paraffined paper sheets, about two by three inches, interleaved with alternately charged tin-foil leaves. Every other tin-foil leaf is connected to a common terminal, as at "A," while the balance of the alternate metal leaves are connected to the opposite terminal "B."

Before going any further, it is well to note that the metal charging plates or leaves of any condenser merely serve to distribute the electric charge from either terminal to the insulating medium, called the *dielectric,* and this dielectric is the member that retains the charge, and *not* the metal electrodes. This being the case, and as becomes evident, the capacity of any condenser depends upon the coefficient of electrostatic induction of the dielectric. This factor is generally called the "specific inductivity" of the material used as the dielectric, and as a basis to work on, air is taken to have a specific inductivity of 1 at standard atmospheric pressure; the inductivity of any other substance is measured by the ratio of the capacity of a condenser, when its plates are separated by that substance, to the capacity of the same condenser when its plates are separated by the same thickness of dry air.

This specific inductivity factor is also known as the "K" value of the dielectric. Any electrical or radio text-book contains a table of the various insulating mediums used as dielectric in building condensers and the corresponding "K" values. A very complete table of these values and of particular service to radio men, appeared in paper No. 3 of this series (see Feb. 1917 issue) and also contains the necessary formulae for computing the capacity in micro-farads of any condenser.

Resuming, Figs. 2-B and C illustrate in a simple manner how a rotary, variable, air dielectric condenser is constructed. A central rotary knob and shaft have rigidly mounted thereon one set of semi-circular plates, which may be turned so as to interleave with a corresponding number of fixt or stationary semi-circular plates. The condenser is provided with a scale which is sometimes calibrated to read in m.f., direct, or else a calibration curve is supplied with the instrument. Low-priced condensers are not usually calibrated, but the capacity may be computed for any position of the rotary plates by means of the formulae in the third installment of this series, above referred to. One terminal leads to the fixt plates, while the second terminal leads to the rotary plates of this type of condenser, and in fact this applies to all other similar types of variable condensers. A variable condenser of the *moving cone* type which has been used considerably in laboratory work is illustrated at Fig. 3-A. This condenser involves the use of male and female conical members, arranged in the manner indicated, so that the inner cone can be raised or lowered by a precision screw adjustment, and the distance between its end and the bottom of the conical chamber of the fixt electrode, as well as the thickness of the air space surrounding the small cone can be varied, and likewise the capacity. Another simple form of variable condenser which has been used extensively in various types of receiving sets, both domestic and foreign, is shown at Fig. 3-B and utilizes one fixt and one sliding brass member, or other non-magnetic metal tubes. The sliding tubular member is sometimes provided with an indicating needle which reads over a scale secured to the base of the instrument. This condenser has a fixt thickness of dielectric, but the length of the active condenser insulation is variable to quite a fine degree.

Fig. 3-C shows what is commonly known as an "adjustable condenser." In this form of condenser the capacity is varied by means of a special switch provided with a multi-fingered blade, so that the capacity of each unit switched into circuit is retained as each successive unit is switched in.

(*Continued on page* 796)

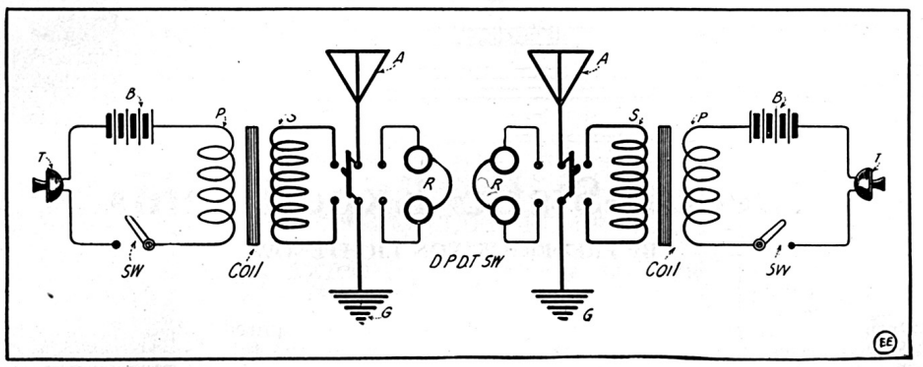
A SECRET RADIOPHONE.

By SEEFRED BROS.

The object of this article is to show how one can use a Radiophone and still not interfere with the radio-telegraph. The voice is very clear, due to the fact that there are not any other disturbances going on while talking. The voice has a ghostly sound. This experiment was carried on by us for several years, and has given very good results. It will usually only work in the daytime in cities, as the arclights on street corners interfere quite a bit at night.

Following is an outline of the talking and hearing instruments:

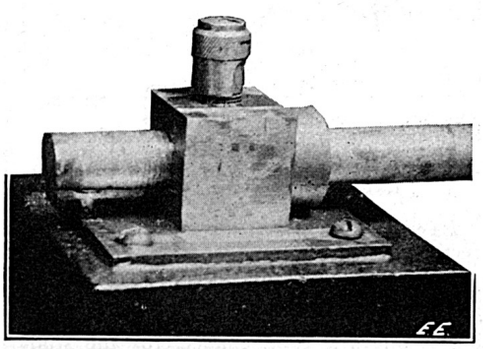
1. The larger the antenna, ground, coil, and source of current, the greater the distance.
2. The higher the resistance in the receivers the better it is.
3. Long distance transmitter (microphone) is preferred.
4. Dry batteries are all right, but would prefer a storage battery for larger coils.



In the Above Diagram of Radiophone Hook-Up A=Aerial, B=Battery, G=Ground, P=Primary and S=Secondary of Spark Coil, and R=Telephone Receivers.

GOOD BEARINGS FOR ROTARY GAPS.

When rotary gaps are to be mounted separately from the motor shaft the question of obtaining suitable bearings must be considered. I have devised a simple bearing which does not necessitate the making of a pattern and casting, which process is usually expensive.



Photograph of Finished Bearing For Rotary Spark Gap.

Obtain full two inches of 1-inch square brass rod and saw off the piece into two equal parts. These rods must be exactly one inch square. Center them in a lathe chuck separately, and drill the hole desired. After taking from the chuck it is necessary to ream out the hole. Drill a hole at the top of each bearing block and fit a small oil cup into same. This cup should have a piece of felt fitted into it to keep the oil from running out too easily. Obtain two sheets of brass 2"x2½"x⅛" each, and drill a hole in the corner of each for screw fastenings.

The bearing is complete after the brass sheet is soldered onto the bearing block. Do not solder around the bearing block but apply the heat directly to the sheeting and apply the solder between the bearing block and the sheeting. If the lathe work is done accurately the bearings will match exactly.

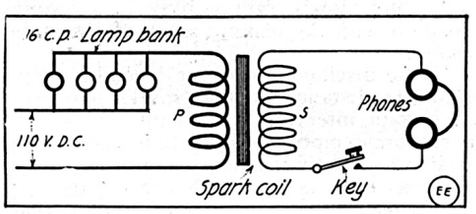
A necessity for each bearing is a movable collar held against the block on the shaft. This collar can be made by turning out on the lathe from 1" round brass stock ⅜" wide. Into this is drilled a hole the size of the shaft. A small set screw is fitted into a threaded hole. In turning out the bearing be sure and drill the holes thru the sides of the rod which were manufactured square, otherwise the bearing will not be true, since it is impossible to file a brass surface absolutely accurate. The accompanying drawings show the general design of the bearings and collars.

Contributed by F. MAC MURPHY.

A GOOD SUBSTITUTE FOR A PRACTISE BUZZER.

The drawing shows the hook-up of the apparatus. The source of current is the 110 volt D. C. power mains. The "Transformer" (if it could be called such, consists of a 1" spark coil having its vibrator shunted with a piece of wire) connected in series with a bank of 16 C. P. 110 volt lamps, which are in parallel. The key is an ordinary telegraph key and the 'phones are the regular, high resistance 'phones used in radio work.

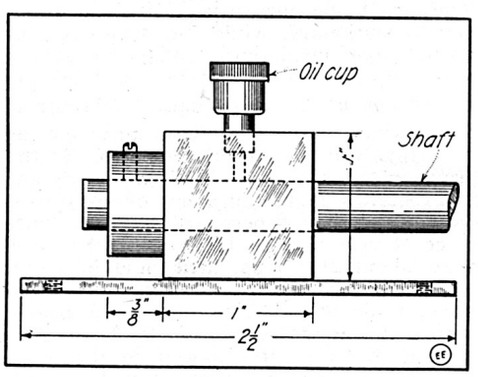
The volume of the sound can be varied in two ways. The more lights in parallel the louder the sound, or if it is impossible to diminish the number of lights and the core of the spark coil is accessible, its removal or partial removal will cause a smaller volume of sound in the phones. This method of substituting a power current for that of a buzzer has several advantages over other methods utilizing the light current as a source. First, it does not click when the key is depress as most of the other methods do. Second, an Omnigraph or other form of automatic transmitter can be used with it without being rebuilt to suit the high power. This idea was original with me, and I hope it will benefit other amateur radio men as much as it has myself.



Unique Hook-Up For Learning the Code By Connecting Spark Coil to 110 Volt D. C. Circuit.

This device should not be used on A. C., but on D. C. It produces a note resembling "N A A" on the 100 K. W. spark set. The tone heard is due to the pulsatory nature of direct current as produced by a dynamo.

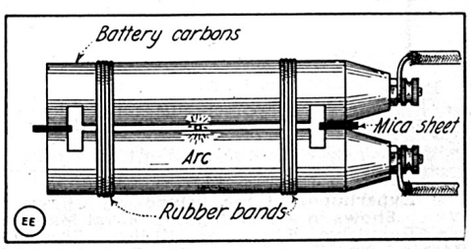
Contributed by PAUL G. WATSON.

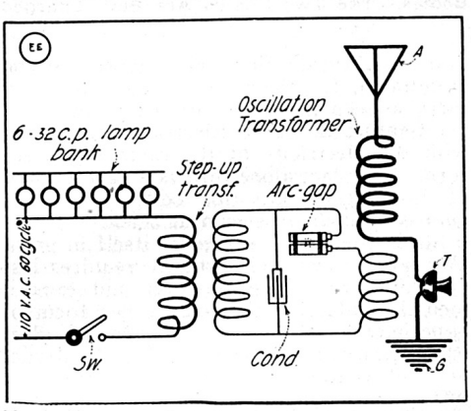


Working Drawing of Rotary Spark Gap Bearing, Fitted With Oil Cup.

AN IMPROVED RADIOPHONE ARC GAP.

Herewith is described an improved arc gap for use in radio-phone work. The carbons are of the ordinary hard variety that can be found in most any dry cells. The advantage of having grooves sawed in each end of the carbons is that it keeps the arc from running along the edge to the end and burning the mica sheets. The mica sheets can be obtained from old fuses. The rubber bands are placed around the carbons to hold them in place and still keep them insulated.





Hook-Up and Detail of Novel Carbon Arc Gap For Radiophone Experimenting.

The color of the arc should be of a blue-purple to give a smooth tone. A white glare is not good as it shows the carbons are burning. The carbons must be at least 1/32" apart to obtain the best results. In this way the voice will be clear and strong, while the arc will be very faint. We find that it is better to have the carbons placed side by side instead of end to end, as it keeps the arc running back and forth on the smooth round side of the carbons, and keeps them cool. Otherwise by having the arc at the ends of the carbons, it stays in one place and tends to heat up and burn the carbons.

We have experimented with this radiophone for three years and have succeeded in talking *thirty miles* distant.

Contributed by SEEFRED BROS.

Now is the time to study up thoroly on Radio and Electricity! You will find hundreds of valuable articles in back numbers of the "Electrical Experimenter.',

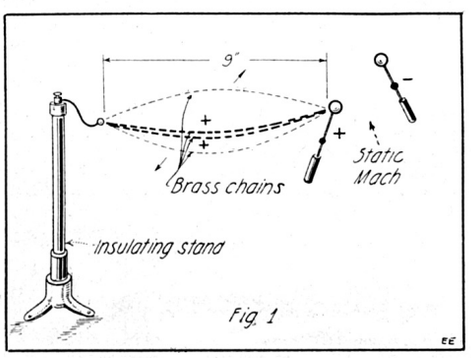
THE CONSTRUCTOR

Electro-Static Experiments

By FREDERICK VON LICHTENOW

PART I

THE attractive and repulsive forces peculiar to *Static Electricity* enable the person experimenting in this field to perform "stunts" which he could not possibly produce with the aid of any other kind of electricity. How-

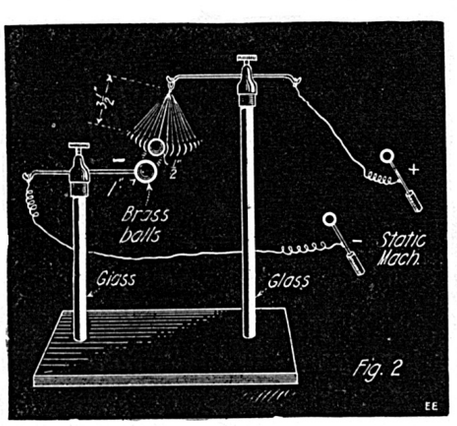


The Experiment of the "Opposing Chains," Which Shows in a Striking and Novel Manner the Repulsive Effect on "Like" Charged Bodies. The Two Chains Are Both Charged Positive.

ever insignificant these may appear to the uninitiated, for the true experimenter they carry a deep meaning back of them. Experimenting in Static Electricity is playing with the electricity of the earth in microform. This fact alone throws a vast amount of fascination into this odd and yet so *natural* branch of electrical science.

Static Electricity evidences itself in probably more ways and certainly requires less apparatus for its production and experimental conduction than any other form of experimental electricity. A rod of glass and a piece of silk or a sheet of hard rubber and a piece of fur, together with some bits of tissue paper, are sufficient apparatus for the practical study of its elementary principles.

A small static machine, however, such as the "Electro" *Wimshurst* type is required for the successful reproduction of the following experiments, which will help the novice in grasping the principles underlying them.



The Static "Ball Pendulum," a Simple and Pleasing Experiment. It Illustrates the Principle of Alternate Attraction and Neutralization.

Experiment No. 1—("Opposing" chains). Here is a simple and yet quite pronounced way of showing the repulsive effect on *like* charged bodies. Two very light and equally long brass chains, such as are usually found around static instruments for connection purposes, are suspended side by side by their respective ends as shown in Fig. 1. They must hang well off the table and under just enough tension to form only a slight downward curve. The electrodes of the machine are then set beyond sparking distance when with a few turns of the crank handle the chains will be caused to press sideways, each strongly repelling the other, in which position they will remain for some time after the machine has been stopt, gradually and slowly falling back into normal position with the leaking away of the static charge.

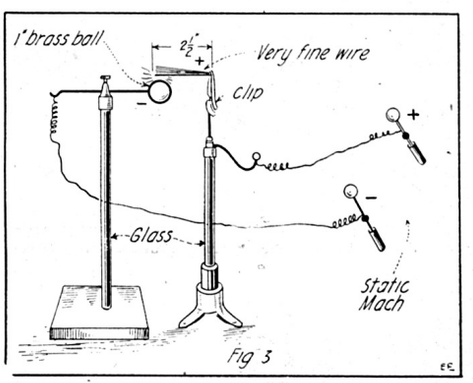
If the discharge balls are brought within sparking distance, so that sparks may pass at certain intervals, the chains will set up a rhythmic motion—separating upon being charged, meeting again upon neutralization—as long as the plates are rotated.

Experiment No. 2.—(Static "Ball Pendulum").

Figure two shows the apparatus needed in this experiment, which clearly illustrates the principle of alternate attraction and neutralization, helped along by the weight of the ball in gathering momentum, which in the end effects the pendulum motion. This latter, naturally, continues as long as the machine is working. Both balls consist of solid brass and should be kept in a well polished condition. The smaller, swinging ball, ½ inch in diameter, is suspended by a piece of very thin copper wire, 3½ or 4 inches long, having a loop on its upper end to insure the necessary free movement. The larger one, measuring 1 inch in diameter is stationary, while the whole is supported upon insulating stands. No sparks must occur across the static machine gap.

Experiment No. 3.—(Static "Vibrator").

Working under the same principle as that involved in experiment No. 2, the static vibrator, as I will call it, forms another highly interesting piece of apparatus. The smaller ball is here replaced by a short piece of very fine, perfectly straight copper wire, about 2½" long, held rigid in a clip as indicated in Fig. 3. The free end of this horizontally placed wire must reach nearly across the entire width of the brass ball, without however touching it in the least, and center upon it. Both should be separated by a gap of from ¼ to ½ inch, this depending entirely on the size and condition of the static machine employed. With the discharge rods set far apart and machine put to work, the wire will immediately be attracted to the ball, since both are oppositely charged, as quickly released under the neutralizing spark, attracted again under the new charge and so on, which, assisted by the springy element existing in it, will cause it to vibrate at an incredible speed.



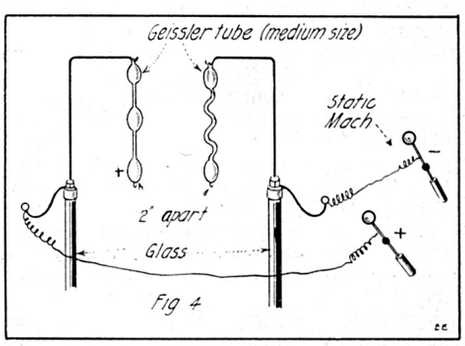
The Static "Vibrator"—a Very Fine Wire Is Suspended by a Clip, as Shown, Just Above a Charged Metal Ball. A Small Static Machine Works This as Well as All the Other Experiments Here Described.

Experiment No. 4.—("Cushioning" effect of spark).

This experiment not only affords a spectacular way of lighting *Geissler tubes* and causing them to swing at the same time, but it offers a good chance, for the study of the "cushioning" effect of the static spark.

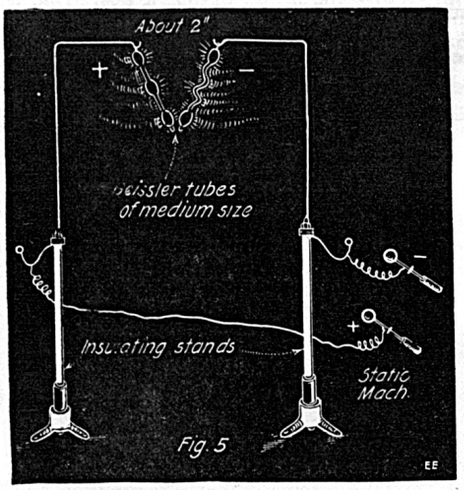
Two medium sized Geissler tubes of equal length (of the rarefied gas and not the heavy liquid type) are suspended a couple of inches or so apart from insulating stands connected to the respective poles of the static machine (Fig. 4).

With the passage of the electric charge they will at once approach each other, being attracted as a consequence of their opposite polarity, when upon meeting by their lower globes the spark discharge will take place thru their entire lengths, strongly lighting them up for the moment. Being released under the effect of the neutraliz-



Experiment to Demonstrate the "Cushioning" Effect of the Static Spark. Two Geissler Tubes Are Freely Suspended, as Illustrated. When Set Swinging the "Spark Cushion" Prevents Their Touching and Breaking.

ing spark, they fall back into their former positions only to be attracted to one another again with the approach of the new charge (Fig. 5). This in repetition causes a sort of swinging motion on the part of the tubes, which in the end—one would



The Swinging Geissler Tubes—a Beautiful and Striking Experiment. Every Time the Tubes Approach, a Spark Jumps Between Them, Lighting Them Up Momentarily. They Then Fly Apart, the Action Repeating Itself as Long as the Static Machine Is Worked.

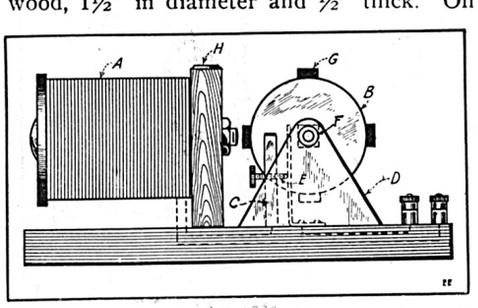
think at least—must lead to their striking hard together; but they never do. Every time they meet, the resulting spark acts as if it were a cushion placed between them; in fact, they sometimes seem to cling together for the instant, while the discharge is taking place, which on the other hand forces them always to a fresh start, in this way limiting the momentum gained by the tubes on each trip. They will perform in this manner as long as the machine is in action, the terminals of which are to be separated beyond their spark limit.

On working out these static "stunts" I had in mind not only the beginner, but the less capitalized experimenter who, unable to buy the more expensive auxiliary apparatus, may not be satisfied with the average run of experiments belonging in the tissue paper-tinfoil-pithball class.

(To be continued)

SIMPLE BATTERY MOTOR.

Herewith I give a diagram and description of a small battery motor. This motor is quite simple and is easily constructed, besides being very powerful for its size. It can be made in any size, but the small sizes give the most satisfaction. The magnet (A) is made by fitting a machine bolt 1½" long thru the ⅜" upright (H) and winding the bolt with No. 26 insulated magnet wire. The rotor (B) is a cylinder of wood, 1½" in diameter and ½" thick. On



Simple Form of Battery Motor of Interest to the Young Experimenter.

its circumference and at equal distances are placed four iron nuts (G). These can be screwed on with flatheaded iron screws.

The shaft can be made of any durable metal, as it has no electrical function to perform. On the shaft, close to the rotor, is placed another nut (F) with its corners pointing midway between the nuts on the circumference. A copper brush (E) is placed near enough to (F) that the points will force it back a short distance. This will make contact with the point (C). The standards (D) are then put on and connections made as in the diagram. The action is as follows: When one of the points of (F) push back the brush it closes the circuit and makes (A) a magnet; (A) then turns the rotor by pulling on the iron nuts. The circuit is opened just before each nut reaches the magnet. The momentum of the rotor brings the next nut in position. If the motor does not start at once spin the armature with the finger.

Contributed by CLIFFORD BROWN.

AN EXPERIMENT IN MR. MACE'S MAGNETIC CURRENTS.

By Thomas Reed.

The very interesting articles by Mr. Mace on "Magnetic Currents" calls to mind, and I believe explains, a phenomenon well known to skippers of small boats, which has never been satisfactorily accounted for. I refer to the "spinning" of a card-compass.

The "dory compass," so called, is composed of a magnetic bar attached to a circular card imprinted with the compass-points. The card, of course, turns with the magnet, and the points are read off against an upright line inside the case, called the "lubberline."

Now very often, as the boat thrashes about in a choppy sea, the card begins to spin. It takes on a rapid rotary motion of something like 200 R.P.M. in its horizontal plane, and keeps it up indefinitely. I say "indefinitely," because I have seen it go for minutes at a stretch; but as it is a great annoyance to the skipper, depriving him of the use of the compass for the time being, he always stops it as soon as convenient, by canting the compass case (which normally is kept level by gimbals) till the card drags on the bottom, and the rotary motion is destroyed by friction.

In the better class of compasses, the case is filled with a transparent liquid (alcohol or oil) in which the card and its magnet are immersed, preventing the spinning.

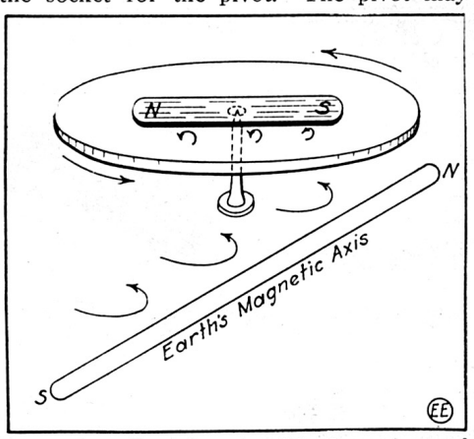
A plain compass-needle, without a card, will not spin. The card seems to act as a fly-wheel, carrying the needle past some sort of *dead centre.*

The spinning seems to be initiated by a succession of "yaws" as the boat is swung off her course by cross-seas. These cause a wide oscillation of the needle; and once these are wide enough, the fly-wheel action comes into play, and the card starts spinning. I have never seen it stop of its own accord, and I believe it would go on until stopt by friction developing at the pivot.

In short, I believe that here we have a case of perpetual motion—except, of course, for friction, which would eventually make the pivot stick. This is a bold statement, because the possibility of perpetual motion is denied. But this is not perpetual motion in the old sense of a force acting against itself; we are merely utilizing an *earth-force* to produce an effect, exactly as a windmill utilizes the wind.

A reference to the diagram will show how I imagine the result to be brought about, in accordance with Mr Mace's theory. In our latitudes, the earth's magnetic axis is very appreciably inclined, which would seem to aid the effect, and perhaps wholly account for it.

It would be a very interesting and not difficult experiment to construct a card-compass especially designed for spinning. Make the magnetic bar rather thin, also beveled and rounded as shown to reduce air-resistance. Attach it on top of the card (it is underneath in the dory-compass) and drill a hole nearly thru from below to form the socket for the pivot. The pivot may



Interesting Experiment with Compass-card and Needle, Which, Under Certain Conditions, Will Spin for Long Periods.

be a fine steel sewing-needle. The card, of thin bristol-board (say 5" diameter), should be as perfectly circular and flat as possible. In operation, it should be covered with a bell-glass to shield it from air-currents; better still, place it in the partial vacuum of an air-pump.

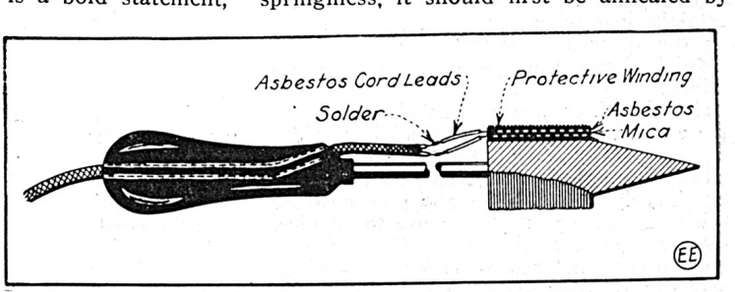
AN EASILY MADE ELECTRIC SOLDERING IRON.

Any experimenter owning a small 110-volt step-down transformer, having a secondary voltage of 15-20 volts, will find the soldering iron here described very useful. When once heated it remains at an even temperature until the current is turned off. To make it, first procure a small soldering copper, of about the size shown. Wrap two layers of thin mica around it, and fasten temporarily with a string. The winding should be of No. 22 or No. 24 German silver resistance wire, the length of which is best determined by experiment. Start the winding about ⅛" from one end, leaving the lead several inches long, and spacing the turns about 1/16".

When as much wire as possible is put on, cover with a layer of mica and wind a similar layer over this. Fasten the end securely, and bring out another lead. The whole winding is now covered with several layers of thin sheet asbestos, and a layer of fine copper or iron wire is wound tightly over this to protect the inner coils.

The leads are covered with asbestos for several inches and are then soldered to a flexible cord which passes thru a hole in the handle. If difficulty is encountered in winding the German silver wire, due to its springiness, it should first be annealed by passing a current thru it until heated to a dull red. If the iron becomes too hot in use, the current should be limited by an external resistance, consisting of several coils of No. 20 German silver or iron wire.

Contributed by AN EXPERIMENTER.

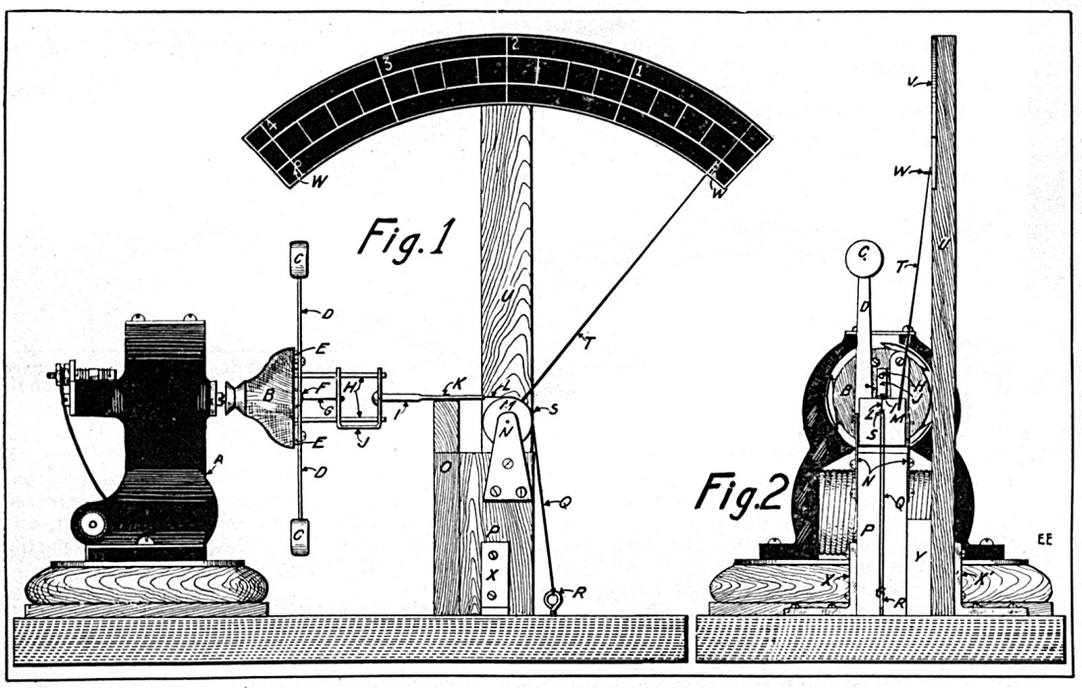


Construction of Home-made Electric Soldering Iron. It Can Be Made from a Standard Copper Tip and Handle, as the Drawing Shows.

A Speedometer for Small Battery Motors

By STANTON C. MOORE

AN easily constructed speed indicator, or more properly speaking, a *speedometer,* for battery motors, that can be made from the odds and ends that are usually found in the ever-useful scrap-box, will no doubt commend itself to the "Bugs" who, being debarred from using their radio sets, are engaged in Electrical Experimenting.



Here Is a Neatly Worked Out Direct-Reading Speed Indicator For Use in Testing Small Battery Motors or For Giving a Steady Indication of the Speed, Where This Is Essential. It Can Be Calibrated to Read R.P.M. if Desired.

While working with a certain device I had occasion to make and break a circuit at certain intervals and also be able at will to alter the intervals and jump to any one of four different degrees of rapidity. I tried an electric clock, but in order to change the period of make and break it was necessary to stop the pendulum to slide the bolts up or down the rod. This was fatal to the device I was working with, so after trying various other schemes, I adopted a modified form of commutator driven by a toy motor. By varying the speed of the motor with a rheostat the periodicity could be changed with ease. However, I found that to get any one of the four degrees of speed that I required, it was necessary to use the "cut-and-try" method of putting in or cutting out resistance until the proper speed was secured.

This was even worse than the clock arrangement had been, but the logical thing to do in this contingency was to devise a method of determining quickly and with certainly just when the right motor speed for the desired periodicity had been obtained. Hence the speedometer here described.

The drawings are presented mainly to give a general idea of the principle and the relative proportion of the different parts rather than exact dimensions, as these depend largely upon the size and power of the motor on which you wish to use the device. However, as it might be of assistance in determining what size to make the various parts to suit your conditions, I give in the following directions, the dimensions of the speedometer which I am using on an "Ajax" motor. These, of course, are arbitrary and may be varied to suit conditions and the material which you are able to dig out of the "scrap-box."

The base is made of half-inch mahogany stock, about 4" x 7". The motor, A, is fastened at one end with the shaft set *exactly parallel* with the center of the base.

Part B is made of hard, close-grained wood (such as mahogany), 1" in its larger diameter and ½" thick, with a hole bored thru the center to fit very tightly and accurately on the projecting shaft of the motor. This hole *must* be bored *exactly* at right angles with the face of the part so that when mounted on the shaft it will run absolutely true. It must be noted that in this device the slightest movement in any of the parts is communicated to the pointer and *multiplied about ten times.* For this reason the utmost care must be taken to make every part as accurately as possible. Otherwise the vibration will cause the pointer to wobble to such an extent that even an approximate reading will be impossible.

Parallel to the shaft hole, 3/16" from it, bore two holes just a trifle smaller than the guides, H. These guides are made from six-penny finishing nails but 1¼" long and forced tightly into the holes just bored on either side of the shaft hole. They should be in perfect alignment with each other and with the shaft.

On these guides is fitted the slider J. This is made in the form of a flat-bottomed "U" of brass, preferably, or iron about 1/32" thick and about 3/16" wide, with holes drilled in each leg to take the guides H. It should slide smoothly on the guides but without too much play. A hole is drilled in one leg to take the link, I. This hole should be exactly midway between the holes for the guides so that the centre of I coincides with the center of the shaft of the motor. A very small hole should also be drilled in the center of the opposite leg to take the cord, G.

To make the link, I, cut a six-penny finishing nail about 1¼" long. File the under side of the head square with the shank and make it as smooth as possible as this joint is where most of the friction comes, and this of course, should be reduced to a minimum. The top of the head may be rounded as shown for the sake of appearances. Insert this in the hole drilled in J to receive it. You will have to bend the slider somewhat to do this, but that can be easily trued up again. Now heat the nail about half of its length and flatten it out. File it smooth on both sides and with a hack saw make a slot the length of the flat part.

The arms, D, may be made of iron, if your junk-box refuses to yield brass, about 1/32" thick and 2" long. Width at one end 3/16", tapering to ⅛" at the other. File them up neatly and drill a hole 3/32" from the large end of each, large enough to take No. 2 three-eighth inch, round-headed, brass wood screws.

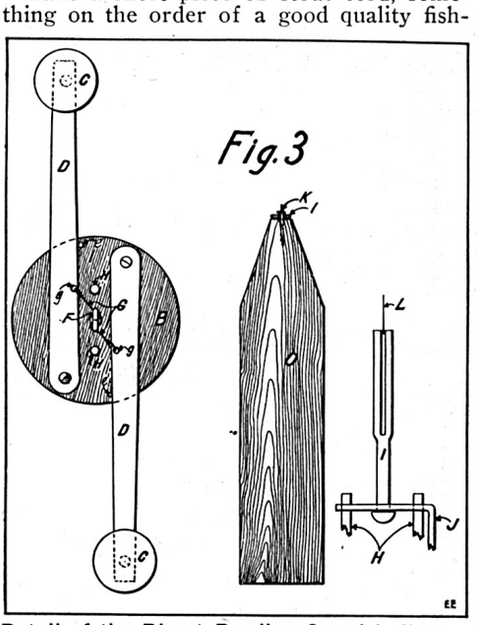
For the weights, C, cut from a piece of sheet lead, about ⅛" thick, two pieces ½" x 1" and fold them in the middle. Drill a hole in the small ends of the arms and slip the folded pieces of lead down over them. Hammer the folds together and you have two arms with a lead weight on the small end of each, the lead sinking into the holes in the arms, thus fastening the weights securely. To make a neat job file the corners off and smooth up.

Five-eighths of an inch from the large end, near the edge, drill a small hole, g, Fig. 3, thru which to thread the cord, G.

These arms are fastened at their large end as shown in the drawing, with a No. 2, three-eighths inch, round-headed, brass wood screw; a washer being placed between the arm and B to minimize friction. The center of the screw should be ⅛" from the circumference of B and 3/16" from a line drawn thru the center of the two guides, H.

A small staple, F, made of *round* wire is now driven into B so that it spans the motor shaft. (I say *round* wire staples advisedly, because if you use the square wire kind such as is employed in tacking down floor matting and linoleum, the sharp edges will cut the cord which we are to thread thru it.) Drive it in all but about 1/16".

Take a short piece of stout cord, something on the order of a good quality fishing line, and put one end thru the small hole in the back of J. Tie the end into a good sized knot so that it will not slip



Detail of the Direct-Reading Speed Indicator Fly-Ball Governor Mechanism and Needle Actuating Means.

(*Continued on page* 805)

My Electrical Laboratory

By WALTER BOCK

(Special prize $5.00)*

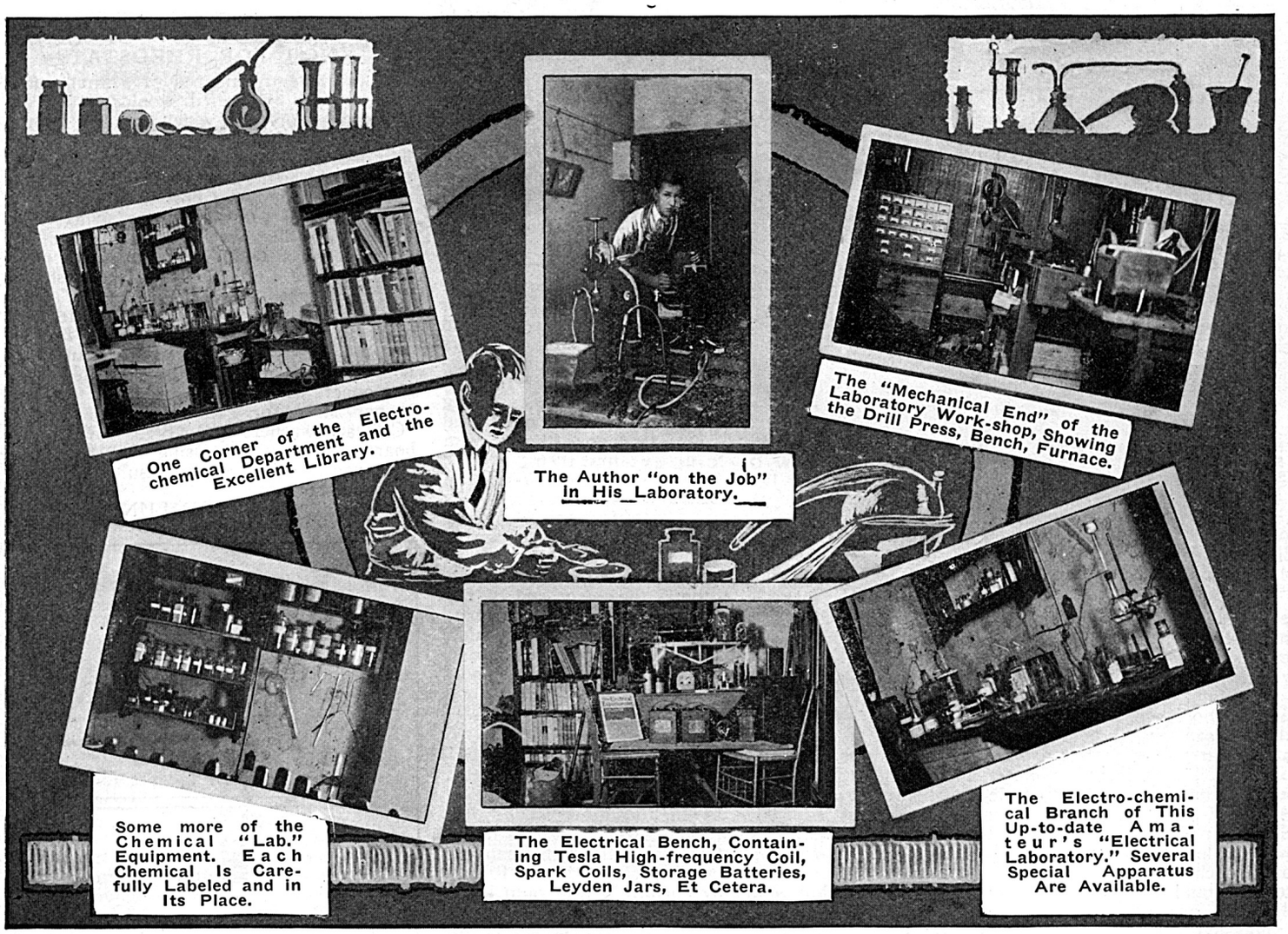
HEREWITH are six photos of my shop and Electrical "Lab" including myself—one "Stript for action" and the others—"all drest up and nowhere to go." The photos show most of my electrical apparatus. All told I have approximately 50 pieces of the same, such as spark coils, Tesla and Oudin coils, Leyden jars, glass plate condensers, magnetos, dynamos, motors, voltmeters, ammeters, polarity indicators, paper condensers from .0165 to 1 mf., rheostats, fixt and variable inductances, Geissler tubes, storage batteries, interrupter, etc.

Owing to the fact that space is limited, (my shop measures 12 feet by 14 feet), I have to put away all apparatus that I am thru using to make room for another experiment. Therefore I have no fixt electrical "Lab." The table of my chemical "Lab" serving the double purpose. One photo shows the "Lab" table with twenty-five of my forty or so pieces of chemical apparatus, such as thistle tubes, test tubes, delivery tubes, retort, Erlenmeyer, and Florence flasks, chemical balance, c.c. graduate, mortar and pestle, etc.

To the right of my "chem. lab" is one of my book cases containing some fifty electrical, chemical, and mechanical books—among others—three volumes, of the ELECTRICAL EXPERIMENTER (I have them all as far back as April, 1915); the Model Library series and Henly's Formulas. Another photo shows some of my 140 odd chemical reagents. The things that look like the noses of some "one-pounders" are the tops of my file handles.

Last but not least comes my bench with more than 300 wood and metal working tools such as twist drills, hand drill, drill press, adjustable tool grinder, and so forth. To the left is my 30 drawer stock cabinet, containing machine and wood screws, nails, bolts, nuts, springs, contacts, binding posts, ad infinitum.

**See announcement in Feb. 1918 issue, page 701, wherein we asked for special article, with several photos describing your "Electrical Laboratory." Tell us in not more than 500 words what you do in your "Lab." Make your article interesting and be sure the photographs are good and clear. Address the Editor.*



RADIO COMMUNICATION BETWEEN FRANCE AND THE UNITED STATES.

A radiotelegraph station destined to establish direct radiotelegraphic communication between France and the United States of America will shortly be establisht by the French Government. It will be situated on the West Coast of France and will maintain permanent and continuous radio-communication by day and by night between France and the United States. It will radiate continuous waves with a wave-length of at least 15,000 meters so it is said.

The contractor must guarantee transmission from the French station to the American station (on any day of the year) of 10,000 words per 24 hours. Moreover, the transmitting and receiving apparatus will be adjusted in such a manner as to allow of continuous transmission and reception at the minimum speed of 4,000 words per hour. Adjustments permitting musical transmission and auditory reception at the speed of 50 words per minute are also provided for.

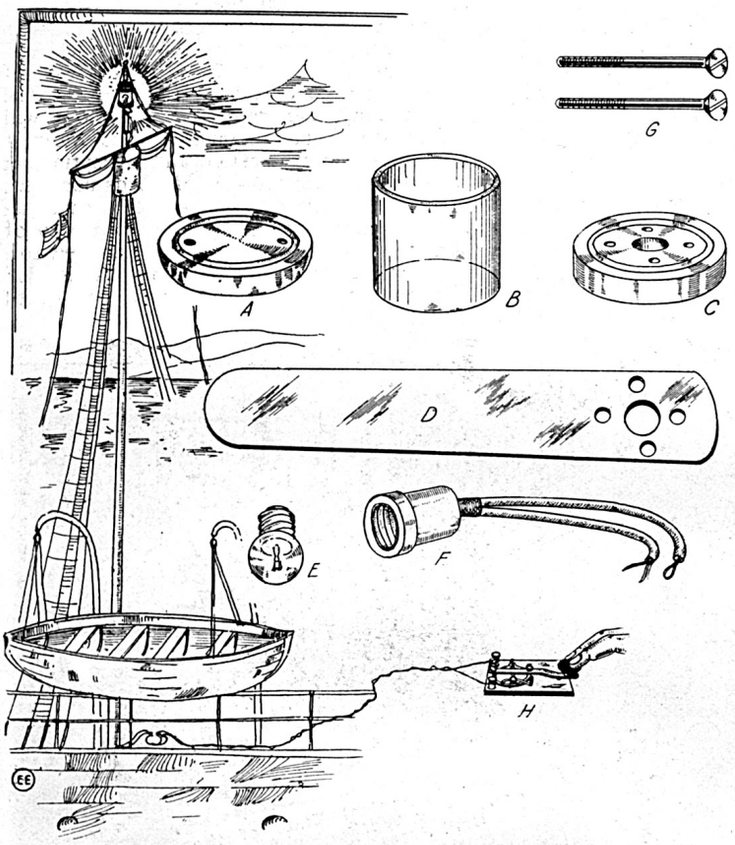
Transmission by the French station of signals destined for reception in the United States of America, and the reception by the French station of signals from the United States, simultaneously and independently, will be correctly and efficiently carried out.

CAMP MEADE PICKS UP RADIOS FROM NAUEN.

Camp Meade's wireless operator (at Baltimore, Md.), Jim McGarrity, caused a tremor of excitement recently when he announced that he had just picked up several messages from the great wireless station at Nauen, Germany. The messages were all in the official German code, and therefore could not be deciphered by anyone here. The headquarters officers would not believe Jim at first the distance to Nauen being more than 4,000 miles. He silenced them by displaying the messages, which were immediately forwarded to Washington.

How to Make a "Blinker Light" for Motor Boats

Every small sailing or engine-driven water craft should be equipt with an efficient "blinker light" for signaling to other craft or to shore. Such a blinker light is described by H. A. Jackson in *Motor Boating*.



Here's a Simple and Effective "Blinker Light" For the Small Motor Boat and Launch. It Can Be Operated From a Few Dry Cells or Storage Battery, the Telegraph Key Enabling Messages to Be Signaled in the Morse Code.

This simply made lamp can be used with equal facility whether it is to be permanently fixt at the mast-head (which is much the better way) or hoisted on the yardarm halliard whenever wanted.

Keeping in mind that the lamp should not be too large, must be seen all around the horizon, and should be neat in appearance, I first tried to buy a plain glass tube of about 2-inch inside diameter and equal length—but found it impossible to obtain. A friend then suggested the kind of glass that is used in oil cups, and my troubles were ended, for I was able to get a glass of ⅜-inch wall thickness (heavy enough to withstand any usage), 2⅜-inch outside diameter, and 2⅜-inch length, at a cost of twenty-five cents. (A good glass cylinder would be one such as supplied on certain radio receiving condensers.)

From the waste pile in the boat yard I then picked a 3-inch square piece of mahogany which was awaiting consignment to the stove, and with a lathe rounded off the top neatly and cut a groove in the lower side ⅜-inch in width and depth and of a diameter equal to that of the glass. I then gave it three coats of spar varnish, and while the last coat was wet, inserted the glass and let it dry. I then had the top and sides of my lamp. For the bottom, I selected a similar piece of wood, left it flat on top and bottom, and on the top cut a similar groove to receive the bottom of the glass oil-cup tube. The center of this bottom piece has a hole bored to ¾-inch diameter for taking a weather-proof tube socket like those used to decorate large Christmas trees outdoors. Having also bored four holes of ¼-inch diameter in the bottom, and put the arrangement together with two thin 2¾-inch brass screws, I had my lamp. Of the four ¼-inch holes on the bottom, two are used for the fastening screws and two for ventilation. I did not insert the glass in the bottom piece of mahogany until the varnish was dry, as this piece should be easily removable for replacing the bulb or cleaning the glass.

When it came to fastening the light, I wanted it to set a little ahead of the mast and above it, so that it would not interfere with the halyards, etc. I therefore took a piece of waste brass 1/16 inch thick, 6 inches long by 1¾ inches wide, bent it to L shape for a bracket and bored holes in it to correspond with the holes in the bottom mahogany piece. In using the long fastening screws mentioned above, I put them first thru the brass. (The illustration shows the brass before being bent and without the screw holes for fastening it to the mast.) The other two small holes correspond with the ventilating holes and the large hole allows the lower end of the weather-proof fixture and the wires to project thru. If it is desired to use this lamp on a halliard, omit the bracket and provide a screw-eye for the top piece of mahogany.

The rest of the outfit consists of a sending key, dry or storage battery, and wires to connect. The sending key can be an ordinary push button, or a regular telegrapher's key. The latter is about twice as expensive as the push button, costing in the neighborhood of $1. But it is much more satisfactory and the light can be made to burn steadily (and so used for an anchor light) by pushing in the right hand arm (see illustration).

The wiring is also very simple, but as the wire is to be used for outside purposes, it should be well insulated. If attached to the mast and painted with a couple of coats of yellow paint, it will not be noticed and the paint will help the insulation. Connect the two wires to those projecting from the bottom of the weather-proof fixture, leading one wire directly to the storage battery (or if you have no storage battery to one dry cell), and the other to the left binding post on the sending key; also run a wire from the right binding post to the dry cell or storage battery. Then, by pressing down the key, you will light the light, and by releasing it will cause the light to go out. A 2 c.p. bulb will be amply sufficient, and the voltage of this bulb should, of course, correspond with the amount of power used. With such a "blinker light" equipment, communication can be carried on at considerable distances.

Important Notice to Subscribers

Due to the congestion existing at the present time in all railroad movements, also on account of the fact that many train clerks have gone to war, there is a congestion of mails all over the United States. It may happen that your magazine will be slow in reaching you, and this delay may be from a few days up to several weeks.

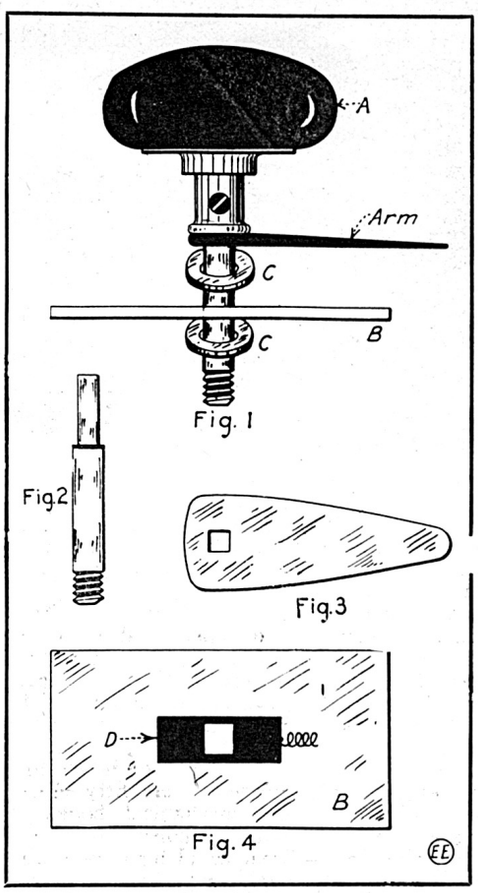
Kindly bear this in mind before sending in a complaint, as the magazine will surely reach you in due time. Only after not having received a certain copy for a period of three weeks should a complaint be sent in.

You will confer a favor upon the publishers not to write until this time has elapsed, thereby saving them a vast amount of clerical labor.

HOW TO GET A PORCELAIN KNOB FOR RHEOSTAT.

I was recently in need of a knob for a rheostat and thought I would try an old porcelain door-knob which was not in use. To construct this knob first procure a porcelain door-knob with a set-screw in it. Next take an old buggy bolt and cut the head off and as much of the bolt as desired. As in Fig. 2, file one end square so as to fit in the door-knob and leave the other end threaded for the lock nut. Procure a piece of brass and cut it into the shape shown in Fig. 3, which is 3½" long and ¾" wide at the larger end, with a square hole in it to fit on the square shank, Fig. 2. In Fig. 4, "B" represents the switchboard and "D" is a copper strip with a hole in the center A copper wire can be soldered on this copper strip for connection. In Fig. 1 "CC" are washers and "B" is the switchboard. I have been using this for some time, and it is giving good results.

Contributed by
CLIFFORD LUNDQUIST.



If You Have a Porcelain Door Knob At Hand Here's a Good Use For It—as a Rheostat Control Knob.

Siphons—How They Work

By I. W. RUSSELL and J. L. CLIFFORD

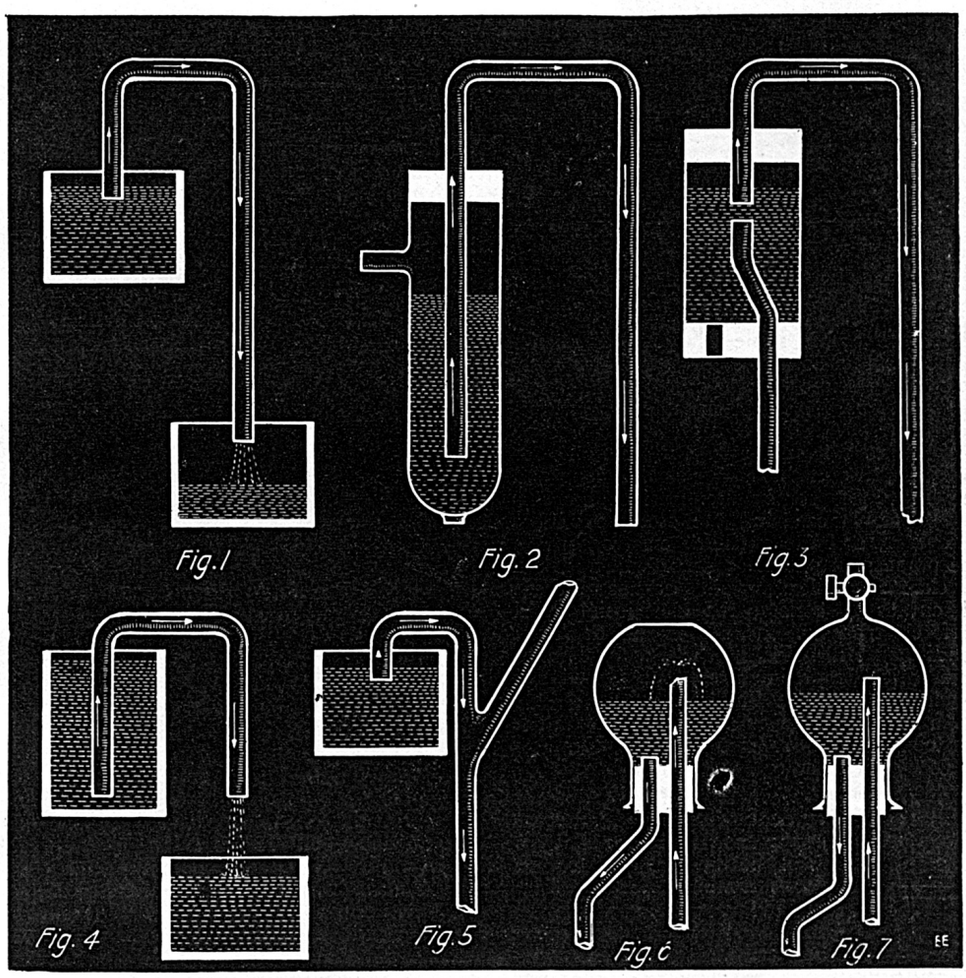
A SIPHON is an instrument for conveying liquid from one vessel to another at a lower level and is usually in the form of a bent tube. The word itself comes from the Latin word "sipho," meaning tube. The principle of siphons has probably been known for centuries; even the ancients were acquainted with the simplest forms of this interesting apparatus. Altho the siphon enjoys the greatest use in laboratories, for the purpose of handling acids, it has a great many other applications. Innumerable forms have been devised and adapted to all purposes. Pipes used for conveying the water of an aqueduct over hills and following the contour of the sides are often called siphons, but do not necessarily depend for operation upon the principle of the instrument defined above.

The simplest form of siphon as illustrated in Fig. 1, consists primarily of a bent glass tube with arms of unequal lengths. In starting this siphon the tube must either be filled with water previous to inserting it in the vessel or, after being placed in the vessel a suction applied to the lower arm. To explain this flow of water from the siphon, let us suppose it to be filled by either method described above and immersed in the liquid. The pressure then at the end of the shorter arm tending to raise the liquid in the tube, is the atmospheric pressure less the height of the liquid in the shorter arm. In the same way the pressure at the end of the longer arm is the weight of the atmosphere minus the pressure of the column of water in the longer arm. Since the column of water in the longer arm is longer than that in the shorter arm, the force acting at the end of the shorter tube is less than that of the longer; consequently a flow of water takes place proportional to the difference between these forces. The flow will therefore be more rapid in proportion to the difference of level between the end of the longer arm and the level of water in the vessel.

In Fig. 4 is shown a type somewhat similar to the first. It consists essentially of a bent tube with arms of equal length. Besides the methods outlined in connection with the first system, this siphon may be started by plunging quickly into a vessel filled to the brim with water. The siphon must be handled skilfully in order not to break the tube and cause the column of water to be forced over the ridge in the tube. Another method is to stop one end with the thumb and inserting the free end into a vessel filled to the brim with water. Upon removing the thumb, the water rises in the tube and is carried over the ridge by its surplus momentum.

A commercial form of siphon intended for transferring acids from one vessel to another is shown in Fig. 5. The principle is nearly the same as the first with exception that the siphon is started by applying suction at the exterior arm. With this siphon, however, there is danger of some of the acid reaching the mouth. In Fig. 6 is shown what is known as the *siphon fountain*. A flask is partially filled with water and glass tubes are arranged as shown in the figure. Upon inverting and with the shorter arm immersed in the liquid of some vessel, a flow is occasioned. As the water is drawn out by way of the longer arm a vacuum is created in the flask, causing the water to rush up the shorter tube, thus forming a fountain.

A commercial form employing this idea is shown in Fig. 7. At the top of the flask there is a valve controlled opening. By stopping up the longer arm and applying suction to the upper aperture, the siphon is started. The valve is then closed and the siphon will then act the same as type 6. For safely and easily handling acids the siphon shown in Fig. 2 has been pronounced by Prof. C. D. Dilts, an authority on siphons, to hold the greatest possibilities. When the siphon is inserted into a bottle of acid the liquid rises into the tube. By blowing in the small tube, the valve at the bottom is closed and the acid is forced out of the siphon tube. With this arrangement there is absolutely no danger of drawing acid into the mouth. A siphon of great scientific interest but of small commercial value is what is known as the automatic siphon illustrated in Fig. 3. The tubes are arranged as shown in the drawing. When this siphon is inserted in a vessel containing water, the water rushes in at the lower aperture and causes a pressure in the larger tube, which causes the water coming up in the lower tube to be forced up into the siphon tube, thus creating a flow. There are many types of siphons other than those shown here which are beyond the limits of this article to describe. As this is an intensely interesting subject, the serious reader will be highly repaid for any labor exerted in experimenting along this line.



A Study in Siphons. These Clever Mechanical Devices Are of Interest to Every Electrical Experimenter For the Purpose of Transferring Acids, Electrolyte From Carboy to Cell or Vice Versa, and Other Work.

METHOD IN EXPERIMENTING.

Experimental work, undertaken in the right spirit, consists in putting a series of questions to nature. The result of the experiment constitutes nature's answer, and when this is correctly interpreted our knowledge of the universe in which we live and of which we form one tiny part becomes more complete. Now if experiments are to lead to fresh knowledge they must be performed methodically. So far as the confirmatory experiments suggested in textbooks are concerned, the conditions are explained by the author of the book, and the experimenter has little to do beyond carrying out the instructions as carefully as possible. But original experiments need to be well thought out beforehand, and when this is done it remains to arrange the manipulative details with a view to getting a clearly defined result, unaffected, as far as possible, by disturbing causes.

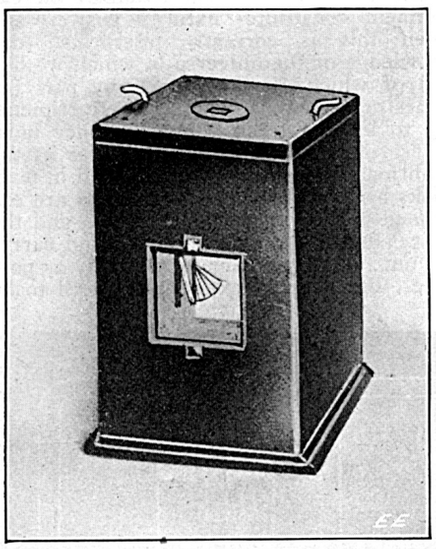
Contributed by H. J. GRAY.

AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

A SPECIAL GOLD-LEAF ELECTROSCOPE FOR RADIO-ACTIVE EXPERIMENTS.

THERE have appeared lately in this magazine several articles on Radium and Radio-Activity. In these articles the experiment of discharging a gold-leaf



Appearance of Finished Electroscope Especially Designed for Conducting Experiments in Radio-Activity.

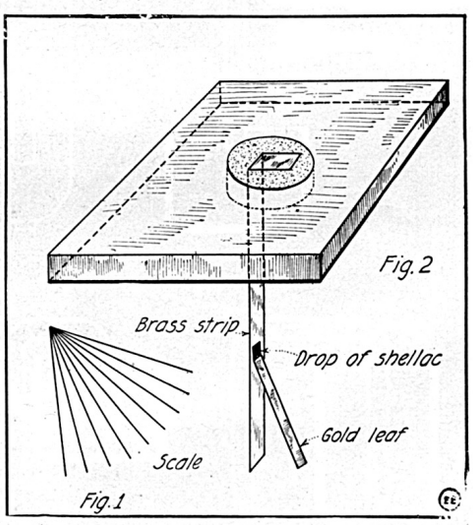
electroscope by some Radio-Active substance is mentioned. This is an intensely interesting experiment, but the ordinary *flask electroscope* is not suitable for this experiment. With the usual electroscope there is no convenient way of bringing the Radio-Active salt near the electroscope and leaving it for some time. Besides there is no way of measuring the collapse of the gold leaf, and the ordinary electroscope in the possession of the amateur will not hold its charge sufficiently well. Because of these difficulties I constructed a special gold leaf electroscope, which, under ordinary conditions, will hold its charge *several hours* and which lends itself especially well for experimenting with Radio-Activity.

As may be seen in the photograph, the electroscope is housed in a rectangular box of ¼" quarter-sawed oak. The box is 3" square at the top and about 5" high. There is no bottom to the casing, and in the front there is a glass window to permit the observer to watch the collapse of the gold leaf. Directly in the rear of the box there is an opening about the size of the front window. Over this opening a piece of semi-transparent paper is glued, on which a scale is drawn as in Fig. 1. This should be put on after the rest is finished so that the scale may coincide with the gold leaf.

The construction of the top of the box is illustrated in Fig 2. A piece of fairly thin brass or phosphor bronze strip about 3½" long and ⅜" wide is smoothed well. Any slight cut or jagged edge is apt to cause leakage. This strip is bent at right angles half an inch from the top, and put thru an inch hole cut in the center of the top. The top of the bend in the strip should be even with the surface of the wood and should not touch the wood at all. The hole should then be filled with melted sulfur. Be sure to heat the sulfur gently, and do not allow it to burn as this destroys its insulating qualities. When the sulfur is hard sandpaper the top so that it is possible to see the top of the strip. The top is put on with thumb screws to facilitate removing and putting on the gold leaf.

Gold leaf can be purchased either at a sign painter's or a paint and varnish store. It would be best to find out when you buy it, how to handle gold leaf, since it is extremely delicate. The piece of gold leaf about an inch long by ⅜ wide is attached to the brass strip by a tiny drop of shellac. It is possible with this electroscope to see the gold leaf and the strip on the scale behind and notice the position before and after charging.

To use this electroscope charge with a glass or hard rubber rod excited with silk or catskin, and notice the position of the gold leaf on the scale. Leave for about fifteen minutes, and if the conditions are favorable, and the electroscope well made, the leaf will be in the same position as before. Take some Radio-Active substance (the writer used Uranium nitrat and Uranyl chlorid) and put upon a grounded copper plate. Charge the electroscope and place over the plate and notice the position on the scale of the gold leaf. After a few minutes again notice the position of the leaf. The electroscope will be discharged. The alpha particles emitted by the Radio-Active substance have ionized the air, permitting the charge on the electroscope to leak away to the grounded copper plate. In this way it is possible to measure the Radio-Activity of different substances by the rate of discharge off the electroscope. The writer has also found that an E. I. Co.'s *Spinthariscope* with the lens removed, would discharge the electroscope. Radio-Active salts (such as all Uranium or Uranyl compounds) can easily be secured at any chemical supply house.



Details of Electroscope For Radio-Active Experiments. It Employs a Single Gold Leaf as Shown, the Movement of Which Is Measured on a Transparent Scale.

This electroscope besides being useful for experiments with Radio-Active substances is a valuable asset to any experimenter's laboratory.

Contributed by JAMES L. CLIFFORD.

THE MYSTERIOUS BEETLE.

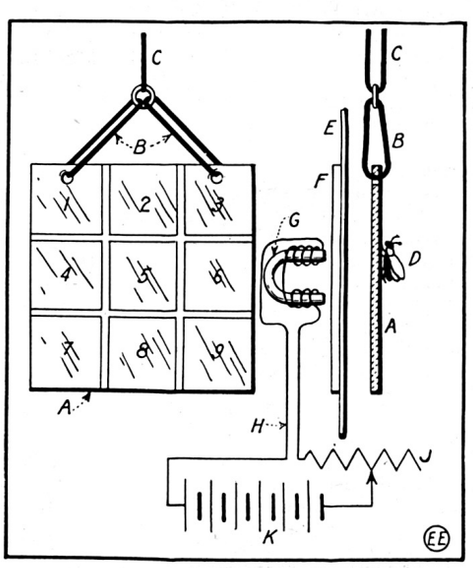
By. C. A. Oldroyd.

This illusion is worked by electricity, and will never fail to keep the audience spellbound. The effect is as follows:

The performer shows a glass plate about one foot square which is suspended from two silk cords B (see sketch), which in turn join the ring that is supported by the cord C. The glass plate A is divided into nine squares, each of which contains a figure starting, of course, with No. 1. These figures and the division lines of the squares are painted with black varnish. The performer shows a "beetle" which, so he explains, he received from an Indian conjurer. The beetle will cling to the glass plate without having any visible support, and will also occupy the squares of the glass plate A, whose numbers are called out by members of the audience.

After these short explanations the conjurer passes the bettle to the audience for examination to show that there are no threads or similar devices hidden anywhere. He also shows that the glass plate is not prepared in any way, and the plate may also be past on to the audience for examination. After this, the performer puts the plate back into its former position, and passes a stick, which he borrows from the audience, between the back of the plate and the curtain E, which is about 6 inches behind plate A. He now places the beetle on square No. 1 and the beetle will cling to the plate. Members of the audience are now requested to call out different numbers and the beetle will slowly move to the square bearing the specified numbers. For instance, if the beetle rests on square No. 1, and No. 9 is called out, the beetle will move from 1 to 5 and from 5 to 9. If the beetle is asked to go back again to No. 1, then it may take the following way: 9 to 6, 6 to 3, 3 to 2, 2 to 1. This proves that the beetle can move in any direction. Small additions or multiplications are also carried out by the ever obedient beetle. After the performance the beetle and glass plate are again past to the audience for examination.

The explanation of this trick is as follows: As mentioned before, behind the plate A at a distance of about 6 inches is a curtain E. Fixt to the back of this curtain is a piece of cardboard F, the same size as the plate A. This cardboard is also divided into nine equal spaces and the position of the cardboard is exactly behind the plate A. The performer's assistant is stationed behind the curtain, holding in his hand a powerful electro-magnet G, which is connected by means of wires H to a resistance J, and a few storage battery cells K. As the assistant hears the numbers called out by the audience he moves the magnet G to the number required. The body of the beetle D contains soft iron wire and the powerful magnet G attracts the beetle and supports it in this manner. The body of the beetle should be as light as possible, and the beetle when completed may be about one inch long. Thin iron wire should be used to form the body and when finished, the beetle should be painted a bright golden color. To make the trick more effective, the room may be darkened and the light of a 50-candlepower lamp may be directed onto the glass plate A. This would show the gold color of the beetle more brilliantly and the beetle will look almost life-like when moving.



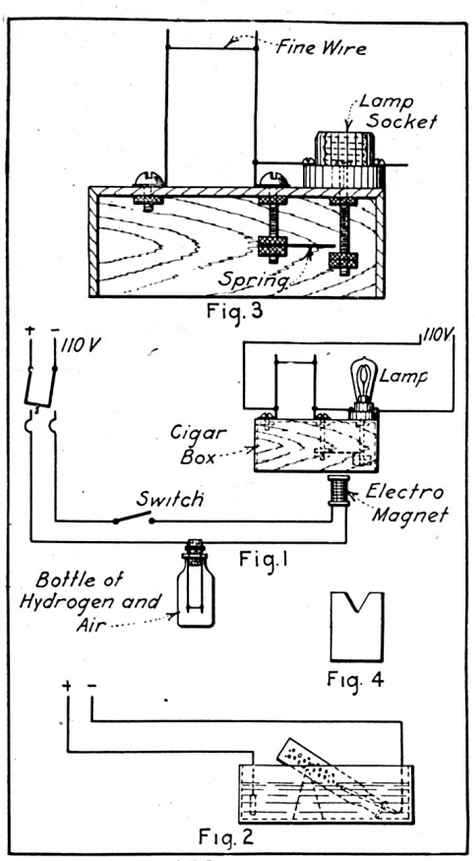
The Mysterious Beetle Is Not So Mysterious After All—For He Is Moved From Square to Square By Means of the Electro-Magnet in the Manner Apparent.

OPENING A LAMP CIRCUIT WITH A PISTOL.

The effect caused by this hook-up is as follows: An incandescent lamp bulb is mounted on a cigar box which also has on it two upright wires, and a small wire connecting them (about No. 36). The uprights and the lamp are connected in series, and they are connected by a lead wire and plug to a lamp socket. The current is turned on, and then the operator walks away some distance, produces a pistol, fires (?) at the wire, cutting it (?), when, Presto! the light goes out!

The way this effect is produced is shown by the diagrams herewith. In diagram 1, the current from the ordinary 110-volt lighting circuit passes thru a switch, a fuse, a fine wire inside of a bottle containing hydrogen and air, an electro-magnet, a strap key or push button, another fuse, and the other blade of the switch. The switch used is a D. P. S. T. with a fuse block. The bottle will be described later, and the electro-magnet consists of about 10 or 15 feet of No. 18 B. & S. gage bell wire wound on a ½-inch diameter iron core about three inches long.

The apparatus at Fig 3 is the cigar box with the lamp socket and wires mentioned above. The lamp socket is of the type with a hole in the center thru which a screw passes to hold it down. The screw used must be about an inch longer than is needed to pass thru the socket and box cover. On the lower part of this, below the nut fastening the socket down, is placed a brass nut with a brass lock nut under it. In securing the socket make sure that the binding post connecting with the lead from the lighting circuit is the one that comes from the center of the socket. The uprights may be of iron wire and are bolted down to the cover. The shove-bolt or screw for the one nearest the socket must be long enough to extend about an inch below the lower side of the cover of the box. After the nut to fasten it to the box cover has been put on, put on another one, then a thin iron plate, and a nut on the bottom. Then we have the plate between two nuts which when tightened will hold it. This plate must be long enough to just miss the bolt which comes thru the socket and as wide as the box, allowing enough room so that it can move freely without scratching against the sides of the box. Then the brass nut on the bolt thru the socket is screwed up until it comes within almost a paper thickness of touching the plate. However, it must not touch. Then the other upright is put on.



It Seems as if the Bullet Severs the Fine Wire Next to the Lamp, Extinguishing It—But Does It? This Trick Is an Excellent One For Parties, Amateur Theatricals, Et Cetera. It Will Puzzle Them All.

The method of collecting hydrogen is shown by Fig. 2. An ordinary iron pan is used, in which there is placed a salt solution and two lead electrodes. The negative electrode is put into the bottle which is filled with the salt solution. When the current is turned on, by electrolytic decomposition, hydrogen goes into the bottle. The bottle should be filled about ⅓ full of gas. It is then taken out, and a cork with two wires bound to it having a fine wire consisting of about two strands of No. 36, B. & S. gage wire across them, is placed in the neck. An ordinary olive bottle has been found very satisfactory for this purpose. The insert shows a convenient stand to avoid "spilling" out the gas while generating it.

Now that the apparatus is completed, the magnet must be hidden under the thing on which the box is to be placed. I put it in my overcoat pocket on the bench by a hatrack and put the box on my overcoat. The jar must be hidden near the place where the gun is to be fired, and the strap key placed where the operator can touch it with his hand or foot.

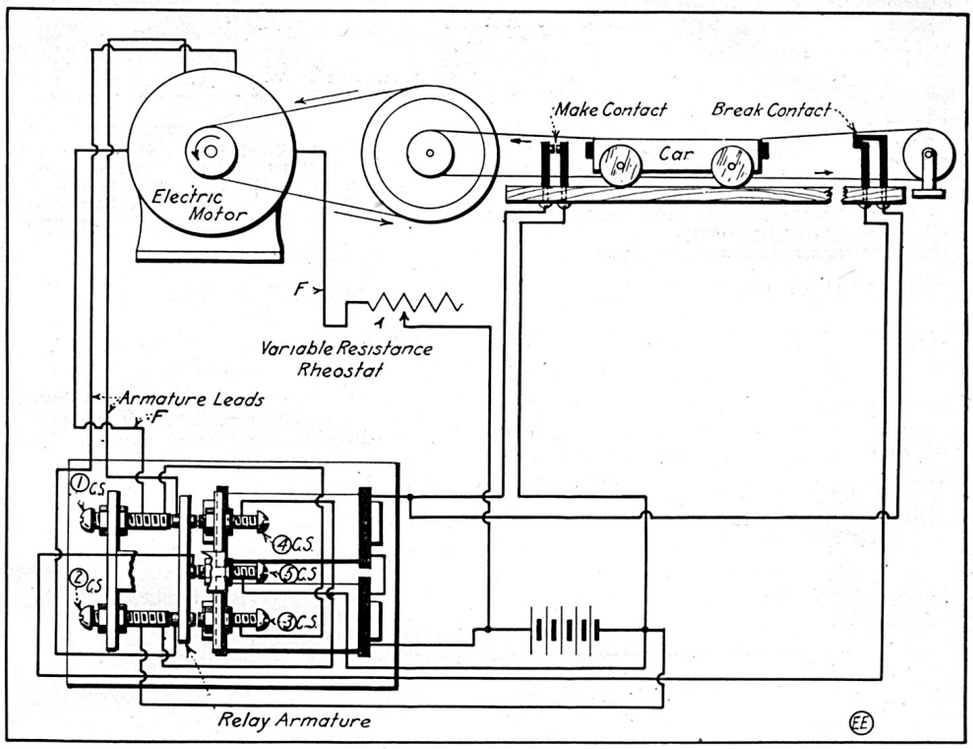
The operation is as follows: When the key is closed, the current excites the magnet, which pulls down the iron plate short-circuiting the lamp. This throws the full 110-volt circuit on the fine wire which breaks as tho it had been severed by a bullet. However, the resistance of the first circuit is so low that there is a heavy rush of current which fuses the wire at its weakest point, which happens to be in the bottle. This fusing causes a spark which ignites the hydrogen and makes the noise required to replace that which the gun would make if it were really fired.

The two circuits may be on the same or different lines, because they are only connected by magnetism.

Contributed by GEORGE S. CARY.

An Automatic Electric Railway

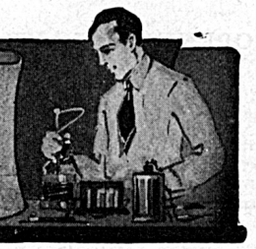
A simple way to run a miniature cable railway mechanically and electrically is shown in the diagram. The apparatus must be operated by a series-wound motor for the connection scheme shown, its armature being connected to the contacts on the relay armature. The field of the motor, thru a variable resistance, is connected to Nos. 1 and 2 contact screw; No. 1 screw being directly connected to No. 3 screw, while No. 2 contact is connected to No. 4 screw. The "make" contact is connected directly in series with the relay coils. No. 5 contact screw is directly connected to the battery, thence to "break" contact, to relay coils, and back to battery. The contact screws opposite each other are connected to opposite sides of the motor field. The forward and backward motion of the relay armature causes the motor to reverse when the relay coils are energized, or *vice versa,* depending on the position of the motor field wires. When motor runs in direction shown in diagram, the power of the car closes the "make" contact, which in turn energizes the relay coils. This causes relay armature to come forward and this action reverses the direction of the motor. On the reversal of the car's motion, the "make" contact opens again, but current is not cut off from relay coils because No. 5 contact screw being directly connected to battery, thence thru "break" contact and relay coils, keeps them energized. The opening of the "break" contact by the car cuts off the current from relay coils, releasing the relay armature and bringing motor back to original position. This action may be repeated as many times as desired. The variable resistance or rheostat controls the speed of the motor.



An Automatic Electric Railway That Electrical Experimenters Will Find Interesting. As the Moving Car Travels Back and Forth On Its Rails, It Trips Electric Contacts Which Serve to Control a Relay Reverser Connected With the Driving Motor.

Contributed by ARTHUR PRIEBE.

HOW TO MAKE IT

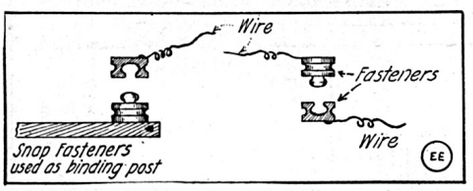


This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of **$3.00** is awarded; for the second best idea a **$2.00 prize, and for the third best prize of $1.00.** The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

LADIES! WATCH YOUR "SNAP FASTENERS"! THEY MAKE GOOD SWITCHES.

The experimenter who is continually rigging up different apparatus, will find that a few "snap fasteners" soldered to different



Ever Hear of an Electrical Use for "Snap Fasteners"? Well, Here we Have a "Switch" Made from One. Watch Your Waists, Ladies!

lengths of wire will come in handy for connecting them temporarily. The dome fasteners can also be used as binding posts.

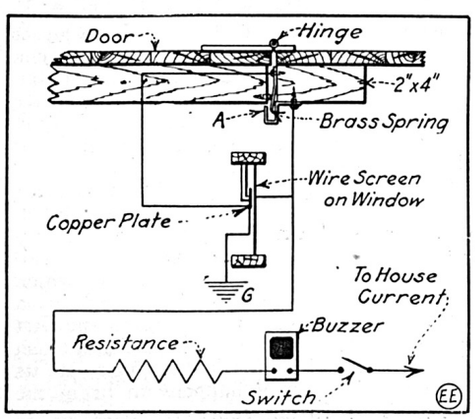
Contributed by S. BELL.

CHICKEN COOP ALARM.

Herewith is a drawing and explanation of how I protected my chicken coop from thieves. By either opening the door or by pressing on the screen window, a buzzer would sound. The coop stands fully fifty feet away from the house, and the incoming wire is hidden under a fence. It works great!

One must be careful to connect the incoming wire to the house current wire which is *not grounded.* The in-coming wire can be led into the house along a fence or any other convenient place.

The action is as follows:—When the door is opened contact is made at A. The wood screw is to adjust the movement of the spring which makes contact. When the wire screen is pushed, it makes contact with the copper plate. Either the screen or the door will operate the buzzer alarm, as they are connected in parallel.



Chicken Thieves!! Beware When This Electric Alarm is Hooked Up to the Chicken Coop.

The switch is to disconnect the buzzer when the door is opened for the day.

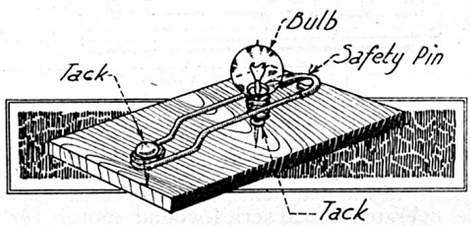
Contributed by VICTOR C. MAZYLEWSKI.

SECOND PRIZE, $2.00

LAMP "SOCKET" FROM A SAFETY PIN.

I herewith submit my idea of an emergency electric lamp socket. This socket may be quickly constructed from a safety pin of large size. It may be placed anywhere. The pin is fastened down by a tack or screw and is bent as shown in the sketch. The lamp is then screwed into the pin.

Contributed by ELLSWORTH EDGERTON.



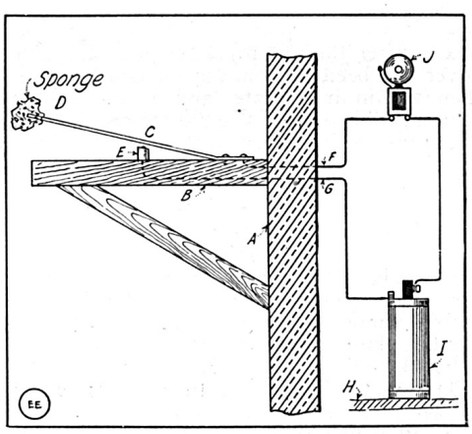
And the Safety Pin—Goldarn it If it Don't Make a Good Hurry-up Lamp Socket.

YE GODS!! ANOTHER RAIN ALARM.

Herewith is a drawing of a simple electric rain alarm. It needs but little explanation.

A is the house wall, B is a shelf, C is a light spring, D is a piece of sponge or absorbent material or a small metal receptacle, E is a contact, F and G are wires, H is a shelf, I is a battery, and J is a standard vibrating bell.

Contributed by HROLF F. LUCK.



Suffering Mackerel! Yes, It's Another "Rain Alarm." And it Works, Yep!

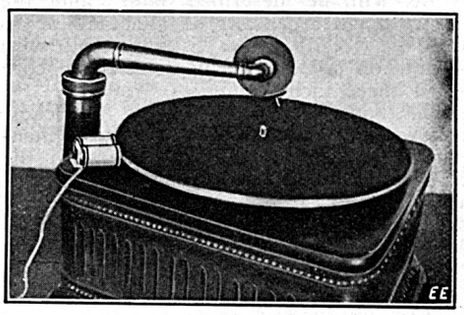
EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

THIRD PRIZE, $1.00

MAGNETIC PHONOGRAPH STOP.

I have found that by placing a pair of ordinary electro-magnets, such as found in



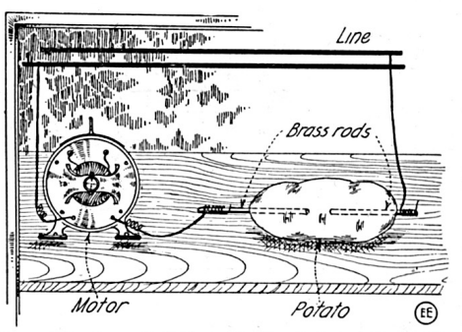
A Pair of Bell Magnets Mounted Alongside of the Record Table Was Found to Stop the Victrola Quickly.

bells, buzzers, etc., along-side of the iron table on my Victrola, that the record is quickly brought to a stop when the current is past thru the magnet coils. It is a simple matter to connect up the magnet circuit with a special trip switch mounted on the tone arm, so that the record table will be brought to a stop quickly as soon as the spring motor is shut off.

Contributed by an EXPERIMENTER.

A "POTATO" EMERGENCY RHEOSTAT.

Are you looking for a rheostat? Then examine the drawing which shows a rheostat made by sticking a brass or copper rod into each end of a potato. The resistance is regulated by bringing the rods close to each other, or by drawing them apart. If this rheostat is used for a continuous period of over one hour, it will be found necessary to replace the potato by a fresh one, as the current passing from one terminal to the other tends to bake it. This makes a very cheap and simple rheostat, even



Two Pieces of Wire Pushed Into Opposite Ends of a Potato Provides an Emergency Rheostat.

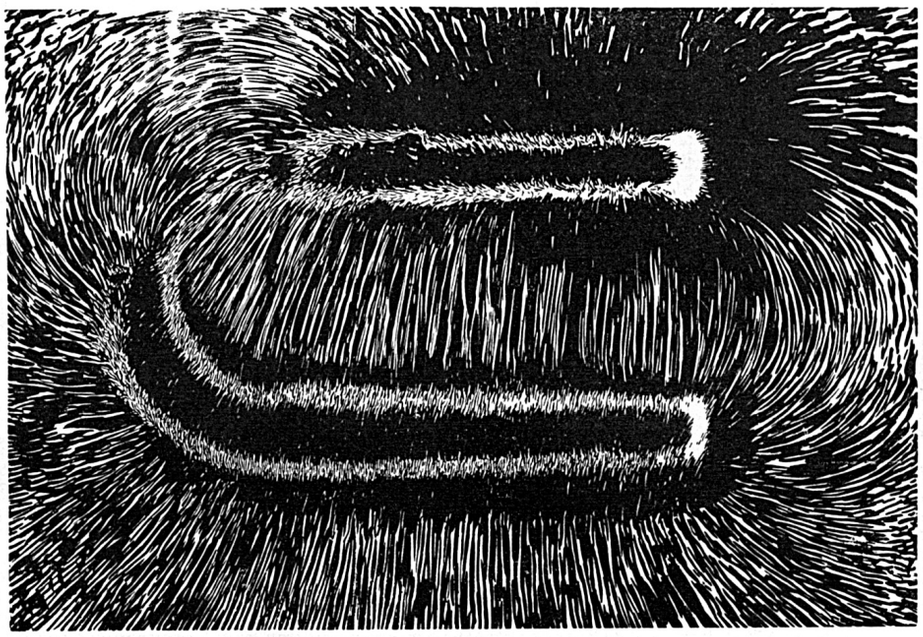
considering the cost of "spuds," which are about $4.00 per bushel. Why not grow some "rheostats?" What next!!

Contributed by RUDOLPH P. KRAJICK.

A Remarkable Magnetograph

Herewith is submitted a print of a "double" magnetic field of a horse-shoe magnet. The cause of this peculiar field is that the steel from which the magnet is made was faulty and therefore causes an unnatural field. However, there seems to be a break in the original magnet, which is a single piece magnet.

Contributed by HAL C. BRANAMAN.

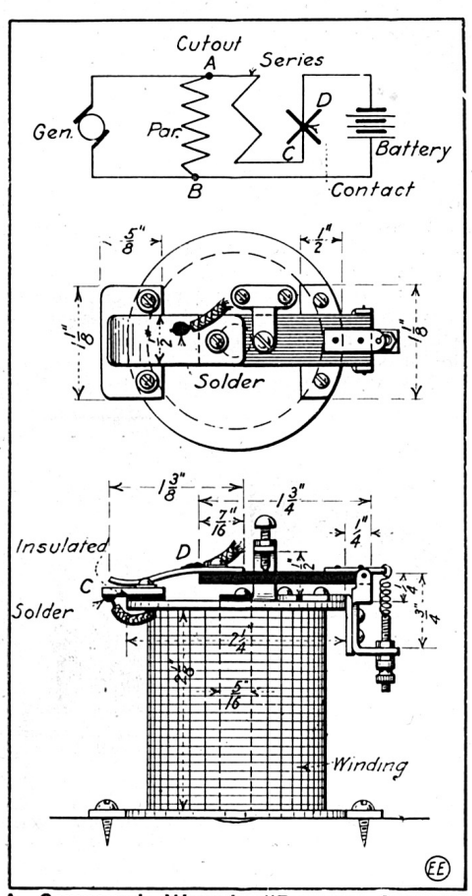


This Photograph of a Magnetic Field Is Unique in That It Shows the Relatively Large Change Produced in the Magnetic Flux About a Horse-shoe Magnet by a Faulty Piece of Steel. A "Soft Spot" in the Steel Might Cause Such a Disturbance.

A "REVERSE CURRENT" CUT-OUT FOR BATTERY CHARGING.

The following is a description for making a *reverse current cut-out* for use with six-volt charging systems. The material that was used in the cut-out did not cost anything, the parts and pieces being selected from my collection of "junk."

The magnet spool consists of an iron bolt with two pieces of sheet brass for the ends. The top end is threaded so that the head will turn down and jam into place. About an inch of thread should be left outside to make winding easier. The bottom end has a shoulder cut on it and then the sheet brass riveted on. The bottom spool head should have extending tabs on it, so that it can be screwed to the wooden base without damaging the windings. All holes in the spool heads should be laid out and drilled before assembly of the spool. In order to insulate the windings, it is necessary to glue a thin piece of fibre to each of the heads, and to wrap 2 layers of paper around the core.



A Compound Wound, "Reverse Current" Magnetic Cut-out for Battery Charging. It Is Automatic in Its Action and Prevents a Storage Battery from Discharging Back Thru the Dynamo.

The mountings are made of sheet brass. The support for the armature and its spring must be made separate from the spool head, because it would be practically impossible to bend this tab over after the windings are in place. The contact plate must be insulated from the spool head. The contact spring must be insulated from the armature.

The armature and tension spring were taken from a DeVeau buzzer, but this combination may be readily made if such a combination cannot be secured. The chief point is that the tension on the spring is adjustable by means of a threaded rod and nuts. The contact spring should be made of spring brass with a flexible conductor soldered thereto.

There are two windings on the cut-out. The inner is a *high resistance* "Shunt" winding, and should consist of about ¾ pound of No. 32 magnet wire. (I obtained this wire from a field winding on a fan motor.) Between the inner and the outer windings there should be several layers of paper. The outer winding is a *low resistance* "series" winding and should consist of three or four layers of No. 18 wire. (I have found bell wire very satisfactory.) The outside of the windings should be well covered with tape and shellacked thoroly to exclude dampness.

The connections should be made as per diagram. Make sure to have the connection at A, make the two windings in parallel *aiding*, not bucking. The other end of the series winding should be connected to the contact plate. The connection from the contact spring goes to the line.

Adjustments: Tighten tension on spring until the cut-out will release when the charging current drops to zero. Then turn down the stop pin until the cut-out will operate when the current builds up to charging value. In making these adjustments, be sure that the armature does not come in contact with the core as then it will take greater tension on the armature spring.

These directions are intended only to supplement the accompanying sketches. I have actually made the cut-out herein described, and since it has been in operation, I have not had a single bit of trouble. In order to keep out dirt, it is well to make a cover for it. It can be used on automobile lighting plants, etc.

Contributed by DAVID MATHESON

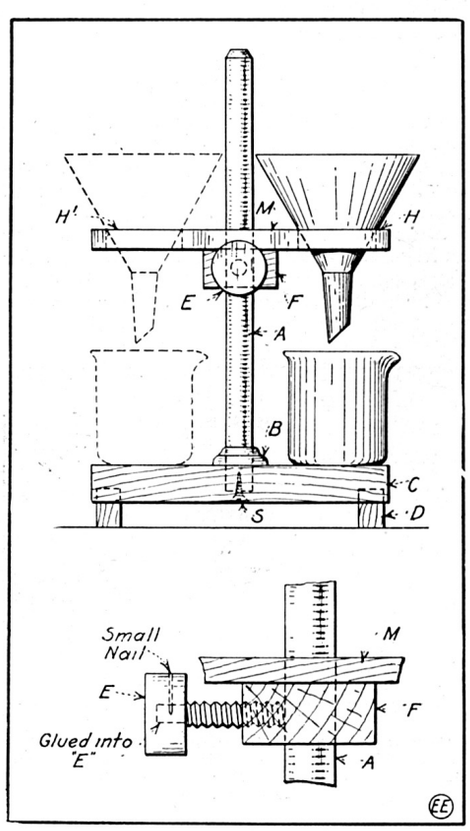
A GOOD FILTER STAND.

Those who follow the "Experimental Chemistry" course in the ELECTRICAL EXPERIMENTER and conduct the experiments will find the apparatus described in this article very useful.

The base (C) is six inches square and cut from oak ¾-inch thick. At each corner small pieces of ½-inch dowel (D) are inserted in holes bored ½-inch deep. The round upright (A) is ¾-inch in diameter and secured in the base by a screw (S).

The piece (M) is of oak, ⅜-inch thick x 6 inches long x 2 inches wide. To this bar is glued the piece (F), 2 inches square and 1 inch thick. A wooden set screw is made and a half-inch hole in (F) as shown in drawing. A hole large enough for (A) to slide thru is bored thru (M) and (F). Two 1½-inch holes, H and H¹ are bored in (M) to hold funnels. A wooden rosette (B) may be added.

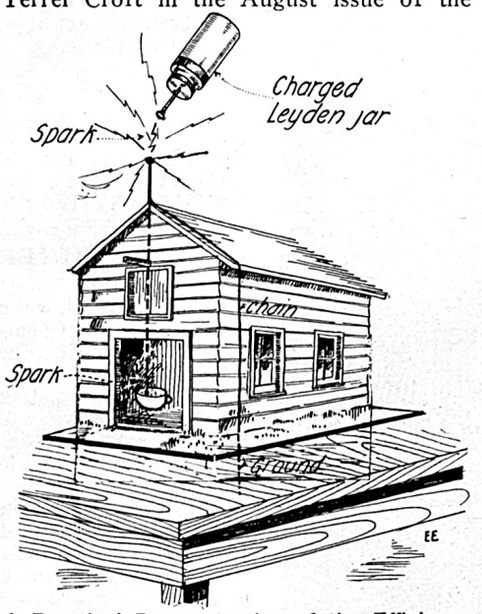
Contributed by D. S. HARDING.



Here Is a Good Home-made Filter Stand for the Amateur Chemist and Photographer. It Can Be Built Any Size Desired and Made to Carry 3 or 4 Funnels.

LIGHTNING EXPERIMENT.

I was much interested in your article on "Thunder-Storms and Lightning Rods" by Terrel Croft in the August issue of the



A Practical Demonstration of the Efficiency of "Lightning Rods." The Leyden Jar Discharges to a Cup of Alcohol, Igniting It, if Lead Wire Is "Ungrounded."

ELECTRICAL EXPERIMENTER, and therefore take pleasure in submitting the following experiment, which I believe will explain thoroly the effect of the lightning rod.

A small wooden building is made, thru which passes a brass rod extending to about 2 or 3 inches from the ground, beneath which a metallic container filled with alcohol is placed (a tin box cover will do). When a charged Leyden jar (or a spark from a static machine) is approached to the top of the rod, a spark will instantly ignite the alcohol, but when a chain or wire running to earth is attached to the top, it will be found that the alcohol will not catch fire, thus *proving the efficiency of the lightning rod.*

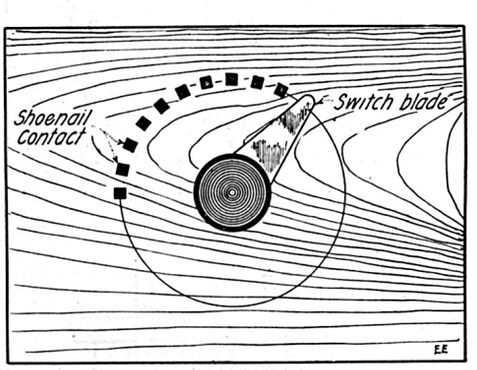
Contributed by EDGAR SINCLAIR.

WHO SAID SHOE-NAIL SWITCHES!!!

In the September issue of the ELECTRICAL EXPERIMENTER, there was a request for some genius to come forward with an electrical use for old "shoe-nails." The said genius has arrived! Hail, hail!!

Shoe-nails make excellent contacts for multi-point switches, such as those used for receiving transformers, loading coils, etc.

The nails are driven into the panel and the leads are soldered to the projecting



Attempt No. 1 At Utilizing Shoe-Nails For Switch Points. Even Mr. Hoover and Dr. Garfield Must Rejoice At the Economics Exemplified.

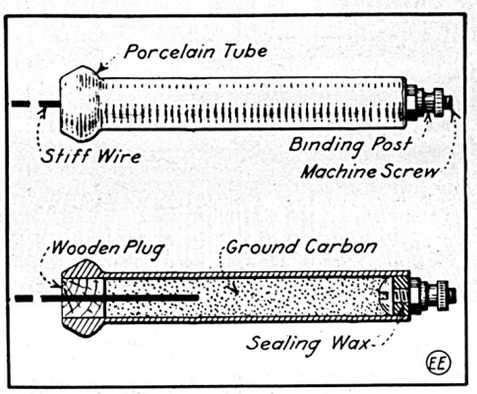
ends. The panel should be thin and of some hard substance to get proper results. Next!!

Contributed by THEODORE SEXTON.

A SIMPLE 110-VOLT RHEOSTAT.

Take a porcelain tube such as is used for house wiring. Procure an 8-32 machine-screw, about 1 inch long, with a head that fills the center of the tube, leaving about ½ inch of the thread projecting beyond the end, Fasten the screw in with sealing wax, taking care that the head on the inside of the tube is not covered. Put a binding post on the screw. Take ground carbon about as coarse as the sand from No. 2 sandpaper and almost fill the tube with this carbon. Plug the end with a wooden plug and bore a small hole thru the plug. Now take a piece of stiff wire slightly smaller than the hole and a little longer than the tube. This rod is to increase or decrease the resistance at will by simply pushing it in or pulling it out. The sealing wax, binding post and carbon I obtained from old dry cells.

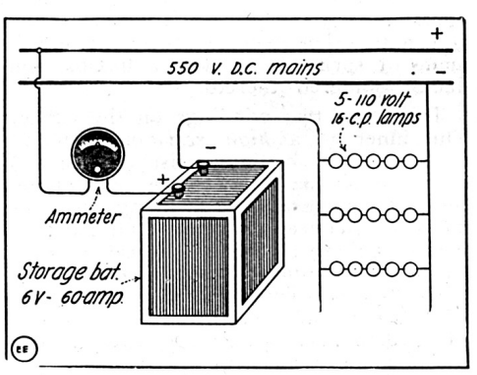
Contributed by ROBERT EASTMAN.



A Simple 110 Volt Rheostat Made of Porcelain Tube Filled With Ground-Up Carbon.

CHARGING STORAGE BATTERIES ON 550-VOLT CIRCUIT.

Charging storage batteries on a 550-volt D.C. circuit can be easily accomplisht, as shown in the diagram, by using incandescent lamps in series with the battery so as to reduce the voltage. Use lamps of 110-volt rating each in series of five, being sure to have the lamps in each group of the same candle-power and current consumption. The lamps may be sixteen, thirty-two, or even higher candle-power. The higher they are in candle-power, and therefore in



Method of Charging Low-Voltage Storage Batteries From 550 Volt D. C. Circuit Thru a Bank of Lamps.

the current which passes thru them at full voltage, the greater will be the charging current for the battery.

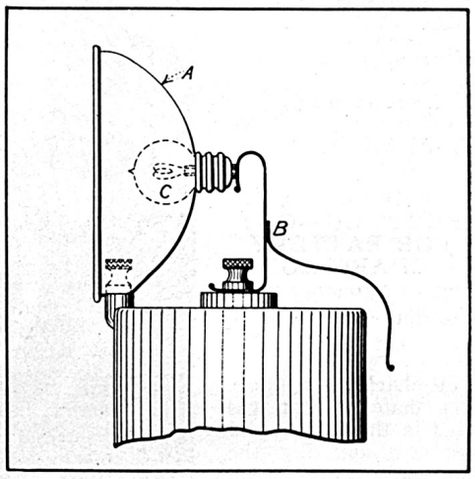
Contributed by PETER J. M. CLUTE.

EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

A DRY CELL LAMP MOUNT.

Procure a reflector (A) from an old "miner's" flashlight and make an 8-32 screw hole in it near the outer edge. Fasten this to the negative pole of the battery with a regular battery nut. Make a brass spring clip (B) about ⅜ of an inch wide, with



A Home-Made Dry Cell Flashlight. It Can Be Constructed From Odd Parts and Gives Excellent Results.

an 8-32 screw hole at one end. Bend as shown and fasten on the carbon terminal of the battery. To turn off lamp turn clip to one side, breaking the circuit.

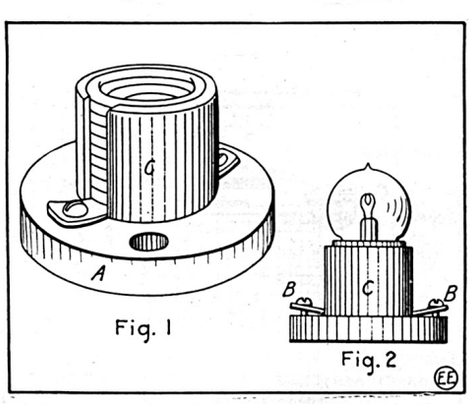
For flashing fasten a piece of spring brass to clip (B) as shown in the figure. This is operated with the thumb. This outfit can be easily adapted to extended carbon types of dry cells.

Contributed by P. B. KINGSLEY.

MINIATURE RECEPTACLE.

In the sketch A is a wooden base 1¼ inches in diameter and ¼ inch thick. B and B are small brass strips ⅛ of an inch wide and ⅜ inches long making contact with the center point of the bulb, and the other being soldered to the wire spiral in the wooden socket. C is a piece of wooden dowel stick ½ inch thick, with a hole for the bulb to fit in snugly. A wire in the shape of a spring is fastened inside the wooden socket by means of a pin bent so as to be used as a staple, and one end is soldered to a spring contact B. Arrange the wire in C so that good contact is made with the side of the bulb.

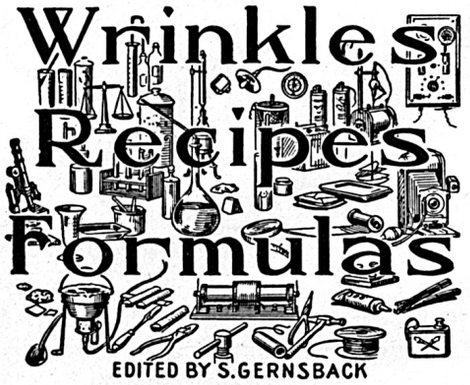
Glue the wooden shell C to the base A. If small brass machine screws can be tapt in strips B and B as binding posts, it will look neater than to put a hole thru the brass parts for the wire to pass thru, and twisting the wire around itself.



Miniature Lamp Socket Constructed From Wooden Shell and Base, In Which a Wire Spiral Is Secured to Form Screw Thread For Lamp.

If good contact is made all around, the receptacle will work as good as one bought from the dealers.

Contributed by WALTER SCHRODER.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

RESTORING THE COLOR OF MAHOGANY.

Add ½ ounce of Alkanet root, cut small, to a pint of linseed oil and when this has stood for about 5 or 6 days add ½ ounce powdered gum arabic and 1 ounce of shellac varnish. Let this mixture stand near the fire for a week and then strain. Wash the mahogany well with soap and water, before polishing with this recipe. This recipe should be handy to experimenters for polishing the bases of their apparatus.

Mahogany Stain. Dissolve Burnt Sienna in vinegar.

To make paper transparent. By dipping the paper in fresh-distilled benzine, paper becomes transparent. This is handy for experimenters who desire to trace designs without using ordinary tracing paper. The paper becomes opaque as soon as the benzine evaporates and it will be necessary to moisten paper again. Ink will not run on its surface when damp.

Contributed by H. HORTHINGTON.

CEMENT FOR CELLULOID.

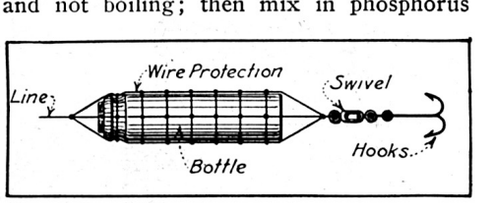
Small celluloid articles can be repaired with this simple cement. Dissolve one part of camphor in forty parts of alcohol and add an equal quantity of shellac.

The cement is applied hot to the parts to be mended and the parts are held together until cooled.

Contributed by
THOMAS W. BENJAMIN.

LUMINOUS FISH BAIT.

All fishermen know that a light will attract fish. The present device comprises a small bottle or vial wound with wire spaced one-eighth of any inch apart. Two hooks are swiveled to the end of the bottle with fish line, tying it to the main line above the bottle. A luminous mixture is then made. Heat some olive oil on the stove for about fifteen minutes, just sizzling and not boiling; then mix in phosphorus



Attracting Fish by Means of a Luminous Bait and Hook.

the size of a small pea. Put in the bottle and cork. This is a fine bait for bass and can be used to an advantage at night. It can be used in winter fishing when the lines are placed thru holes in the ice.

Contributed by RICHARD ANDRESS.

FOR FIREPROOFING ANY KIND OF FABRIC.

A very good formula for this purpose is as follows:

Boric acid, 50 grams.
Borax, 60 grams.
Water, 1,000 cu cms.

Paint or soak fabrics in the solution; then either hang up to dry or press fabric with a hot iron.

Contributed by ALBERT W. PUTLAND.

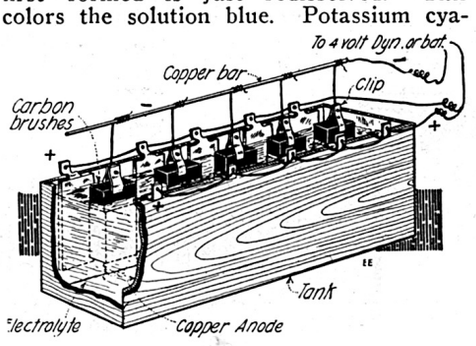
COPPER-PLATING CARBON MOTOR BRUSHES.

It is usual to thoroly copper plate the better class of motor and dynamo brushes made of carbon to improve their surface conductivity, and this may be accomplisht in the following manner:

The carbon brushes are usually cut from flat carbon plates of the desired thickness and measuring 12 by 12 inches. They are cut out in strips, which are then separated into the proper lengths by means of a high speed carborundum or corundum wheel about ¼ inch thick and 12 inches in diameter, rotating at high speed.

The brushes are first washed thoroly and after drying they are dipt in pure paraffin, when they are placed in a bake oven and heated at 110 to 115° F. temperature for 20 to 30 minutes.

They are copper plated by immersing in an electrolyte bath. For small tanks the bath is prepared by mixing two pounds of copper sulfate with one gallon of water and adding ammonia until the precipitate first formed is just redissolved. This colors the solution blue. Potassium cyanid is then added until the blue color disappears. This bath should be used at a temperature of 122° F. to 131° F. Another bath, which may be used cold, is composed of a copper sulfate solution with 1/10 of its volume of sulfuric acid. Its density should register 1.197. This bath cannot be used for metal objects attacked by the above chemicals.



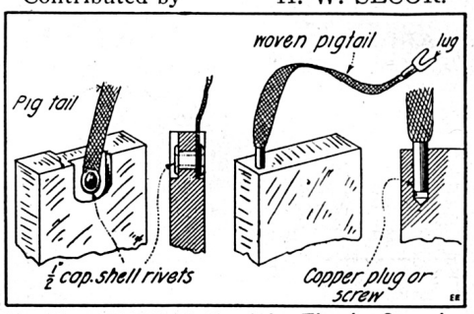
Copper Plating Carbon Brushes in Electrolytic Bath.

Pure copper anodes are placed in the bath, and these may be cut from pure copper sheets about ⅛ inch thick. The carbon brushes are held by spring clips, resulting in about ½ inch of the brush remaining unplated, but this is all right, as the unplated edge is the one ground down to fit the commutator curvature, and the copper plated surface need not necessarily reach the commutator.

The electric current required for a small plating tank is 15 to 20 amperes at 3½ to 4 volts, and a regular electro-plating generator is best employed. The brushes are plated from 4 to 6 minutes generally, but this will vary with the temperature of the electrolyte and the amount of current used.

A little experimenting will soon tell as to how long the brushes should be plated and as to the proper strength of current. It should be possible to regulate the latter by means of a rheostat. If the plating is done too rapidly by using too strong a current then the metal deposit on the brushes will tend to peel or turn black. Hints are given in the illustration for attaching the "pigtail" connectors.

Contributed by H. W. SECOR.



Details of Method Used in Firmly Securing Pig-tail Connections to Carbon Brushes.

HAND GRENADES.

It often happens in a laboratory that some inflammable acid is accidently spilled or some chemicals which do not agree be mixed. A very bad explosion or fire is usually the outcome of such mistakes.

A sanitary and safe device can be made by the experimenter at the cost of a few cents which will end chemical fires as quick as they begin.

It consists of a mixture of chloride of calcium, twenty parts; sodium chloride (common salt), five parts, and water, eighty-five parts. Several small thin bottles are purchased, filled with this mixture and corked.

When a fire occurs, one of these grenades should be thrown in such a way that it will break in or near the fire which will quickly be extinguished. Contributed by
EDWARD G. WILSON.

RADIO-ACTIVITY FROM GAS MANTLES.

Here is an interesting experiment on Radio-activity. I obtained some Welsbach gas mantles and powdering them and placed the same in a cardboard box. I then put a key in the powder and covered it with a piece of cardboard, on top of which I laid a piece of sensitized photographic paper with the sensitized surface down. The above operations were all done in a dark room lighted only by a ruby lamp. The box was then covered and left in a dark room for one week. At the end of this period I found that upon developing the photographic paper that there was an indistinct impression of the key on the same. The radio-active rays which are a property of the rare metal, Thorium, a small quantity of which is contained in these mantels, had past thru the cardboard and affected the sensitized paper.

Contributed by R. E. RAPP.

HOW TO CUT THE TOP OFF A BOTTLE.

Cut a piece of filter or blotting paper in two narrow strips, moisten same and paste around the bottle, each piece of paper parallel to the other, leaving between them a narrow space, marking the place where you want to cut the bottle. Now hold the bottle over the flame of a spirit lamp and turn slowly so that the bare space is heated evenly; after about a minute the glass will break quite clean and will only need to be filed smoothly to take off the sharp edges.

Contributed by G. M. BLUM.

POLE INDICATING SOLUTION FOR BATTERIES.

Formula.—Water, 1 teaspoonful; Phenolphthalein, 3 drops; Potassium Nitrate, 1 teaspoonful.

Directions for Use.—Dip wires into solution, and the one which is negative will color the solution about it red.

Contributed by
BENSON FREEMAN, JR.

Experimental Chemistry

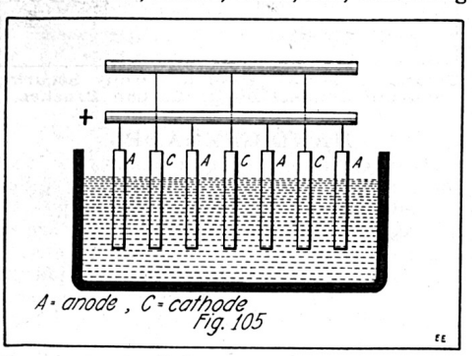
By ALBERT W. WILSDON

Twenty-Second Lesson

APPLICATIONS OF ELECTRO-CHEMISTRY.

ELECTRIC REFINING OF METALS.

THE process of electrolytic refining of metals, altho wide in application, has as yet been chiefly restricted to the refinement of copper. The metal has been obtained as "blister" copper from its ores, sulfids, oxids, etc., containing



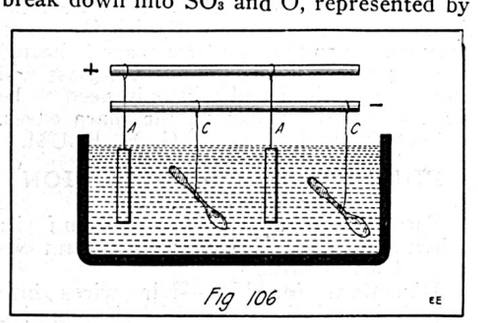
Arrangement of Apparatus for Electrolysis of Copper, Etc. A-Anode, C-Cathode, Both Immersed in Solution of Copper Sulfate with Sulfuric Acid.

many impurities which it is necessary to remove. A solution of copper sulfate with some sulfuric acid is put into a vat or tank, which is connected with the source of electricity, and a bar of thick plates of the crude impure copper is then suspended in the solution, and made the *anode*. The *cathodes* consist of very thin plates of the pure copper. (See Fig. 105).

The curent causes the copper ions from the copper sulfate in solution to deposit on the copper cathode, while the sulfate ions at the anode form a complex reaction, the result of which is to dissolve off more copper from the anode, thus tending to keep equilibrium in the solution. The *impurities* from the copper anode gradually settle in the bottom of the tank, and only pure copper collects on the cathode. Millions of pounds of copper are refined by this process each year in the United States, and since the beginning of the European War the output has increased to a very marked degree, having changed from a purity of 95 or 98% to practically 100%. This is called *electrolytic,* or refined copper. Native copper from Lake Superior does not need this refining, and usually sells for a fraction of a cent a pound higher than the electrolytic variety.

Theory.

The theory of this action is that the copper sulfate molecules break up into copper and sulfate ions by solution. When the current passes, copper ions deposit as copper atoms on the cathode, (C in Fig. 105); sulfate ions at the anode (A in Fig. 105) become sulfate radicals, and at once break down into SO_3 and O, represented by



How Silver-Plated Articles Are Coated with Precious Metals by Electrolysis. The Spoons, Etc., Form the Cathode, a Bar of Silver Serving as the Anode.

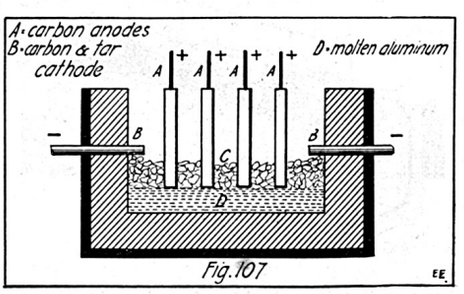
the equation $SO_4 = SO_3 + O$, the oxygen being liberated and set free, while the former, SO_3, having a strong affinity for water, combines with it to form sulfuric acid, which at once dissolves from the anode to form copper sulfate, which is

$$\overset{++}{Cu}\ \overset{--}{SO_4}$$

ionized to Cu and SO_4, and the operation is rendered continuous. No new supply of sulfuric acid or of copper sulfate is needed. The bar of impure copper becomes reduced as the refined metal increases at the cathode.

The tank house of one modern electrolytic plant for refining copper is 600 by 200 feet, contains 1,600 depositing tanks, each having 22 copper anodes, each of which weighs about 400 pounds. These are put in place by means of cranes, and after being allowed to remain in the tank for about 43 days the remnant is taken out as scrap and resmelted. The cathodes (refined copper) are taken out every 7 days with the employment of cranes, a tankful at a time. Slimes are removed once in three months. The liquid contains from 12 to 20% copper sulfate, and from 4 to 10% of sulfuric acid.

The electrolytic refining of zinc and nickel have also been tried on a large scale but have not been as yet entirely successful. The zinc deposit has a tendency to be spongy and readily oxidizable and the nickel ores require previous smelting and contain many impurities.



Modern Method of Obtaining Pure Aluminum by Electrolysis. A Set of Multiple Electrodes (Carbon Anodes-A) Are Inserted in the Ore to Be Reduced as Shown, the Molten Aluminum Accumulating at "D."

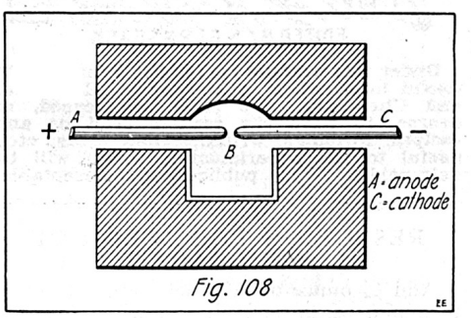
The recovery of metallic tin from scrap tin plate is another application of electrolytic refining that has been developed quite extensively in recent years. It takes place in alkaline solution and the tin goes into solution as an alkaline stannat.

The electrolytic refining of silver and its separation from gold and platinum contained in the silver bullion is also extensively practised and is gradually superseding the method of "parting" by nitric acid.

Electrotyping.

The process of electrotyping is almost the same as that described in refining copper. Most books are now printed from electrotypes, as are the entire pages of this journal, and they are also employed for printing maps, illustrations and numerous periodicals, etc.

The type is first set up, making pages of the size desired. An impression is made of the type or wood cut in a mineral wax, which is composed of a mixture of beeswax, turpentine and grafite, so as to have an exact opposite of the face type; that is, the projections of the type form indentations in the wax. The plate is called a *case,* and is impregnated with a fine coating of powdered grafite which affords the *conducting surface.* These impressions are hung from copper hooks, and form the cathode, in a vat containing a strong solution of copper sulfate acidulated with sulfuric acid, and a bar of copper forms the anode, as was the case in the refining process. Copper is deposited on the grafite cathode of wax to any desired thickness, and it reproduces faithfully every projection, indentation and line of the original. It is permitted to remain in the bath from



Moissan's Electric Furnace. Space Is Provided at "B" for Substance to Be Electrically Melted. In Such a Device Small Diamonds Have Been Made from Carbon.

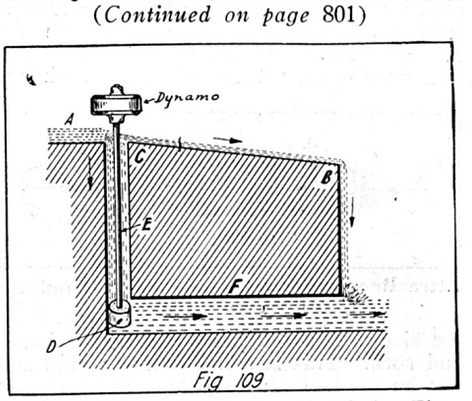
three to eight hours, depending upon the thickness desired. The film of copper does not adhere to the wax or grafite, and can be easily removed by hot hydrochloric acid. After removal from the moulds, the back is cleaned, a thing layer of tin foil is melted on it, and finally it is filled with molten type metal to render it rigid. The face is then of rigid copper, which is mounted on a suitable wooden support, called a block. This copper electrotype is harder and more lasting and durable than type metal. Copper is practically the only metal used for electrotyping. Recently a process was invented for electrotyping by steel, which is much harder and more lasting than copper, but its drawback lies in the fact that it rusts, and it probably will never entirely supersede copper.

Electroplating.

Electroplating is the *electrolytic deposition* of one metal upon another. It differs from electrotyping in that the deposit of copper or other metal is fixt permanently on the surface of the base metal, which forms the cathode, and is not removed, as was the case of the former process. The chief metals employed for electroplating are; gold, examples of which work are gold-plated watches and cigarette cases, etc., silver, used to plate knives and forks, etc., nickel, copper and platinum, and such alloys as brass and German-silver.

The cathode, which may be iron, copper, brass, bell metal, or other base metal or alloy, is first very thoroly cleaned with sulfuric acid to rid the surface of all traces

(*Continued on page* 801)



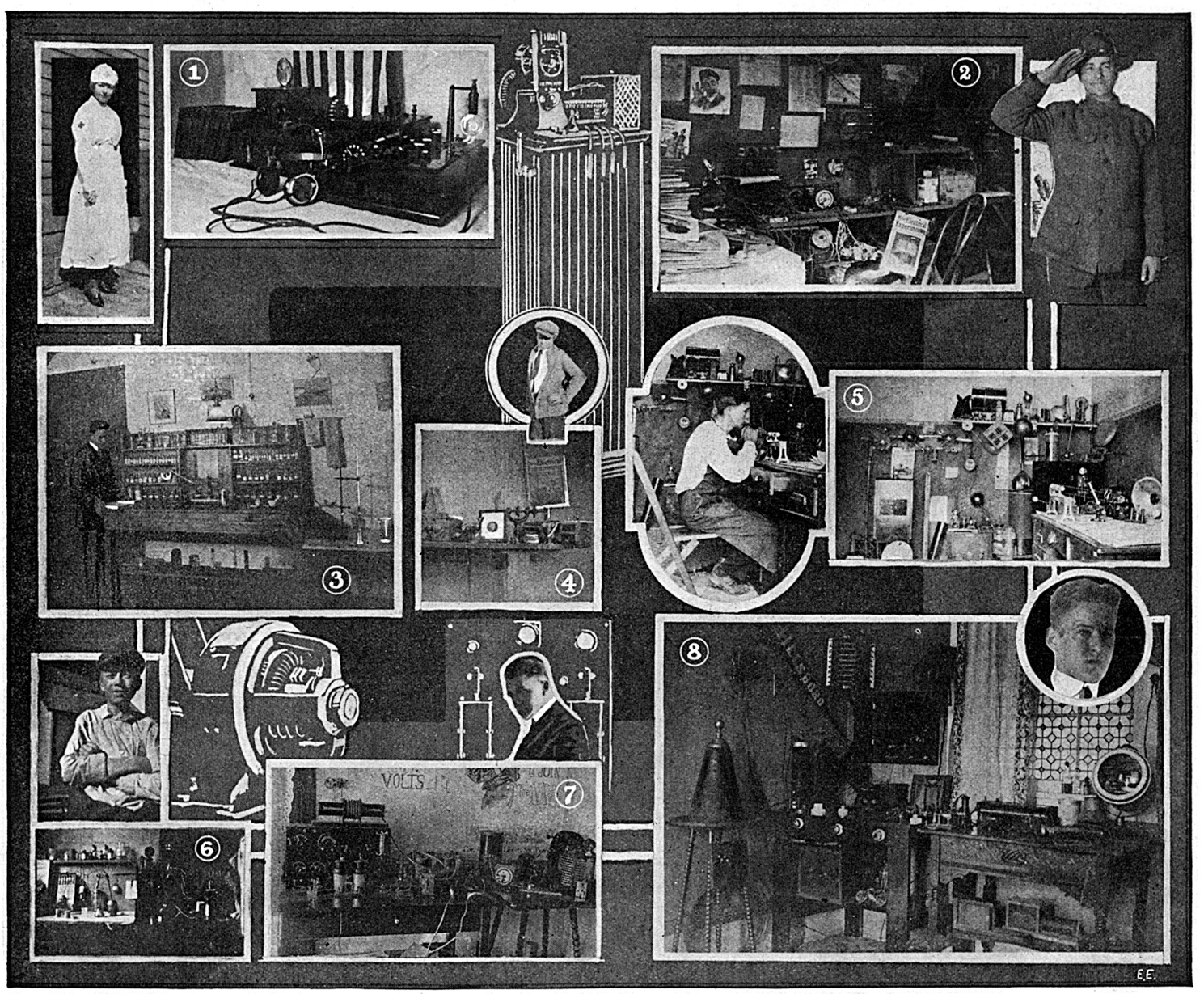
Sectional View of the Gigantic Hydro-Electric Plant at Niagara Falls. A Case of Utilizing the Chemical Action of the Sun's Rays Indirectly.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

As announced in this department in the February issue, we are desirous of publishing each month a special article describing an exceptional Amateur Electrician's experimental laboratory. Such a laboratory will be found illustrated and described with several excellent photos on another page of the present issue. For prizes and instructions in preparing the articles and photos see the February issue. We now wish to say a few words with regard to the present laboratory contest. We are pleased to bring to the attention of all Radio and Electrical "bugs" two ex-radio amateur enthusiasts, who are shown in the photos at the upper right and left corners of the group. At the left we have a photo of the wireless set used prior to the war by Miss Edith Charmont of Cleveland, Ohio, and who has now joined the American Red Cross. She will probably go across the ocean and join in the "big game" before long. We are pleased to introduce a well-known ex-radio amateur—9 TL—known to his friends as Forest Longbrake, of Sheffield, Mo., but more recently of the 313th Field Signal Battalion at Camp Dodge, Iowa, and who expects soon to "go across" to France. Mr. Longbrake mentions that he has done lots of long distance work in the good old amateur days, with the set illustrated in his laboratory below. Once more—don't forget to read the important announcement in the February issue. Address all photos and manuscripts to the Editor "With the Amateurs Prize Contest."



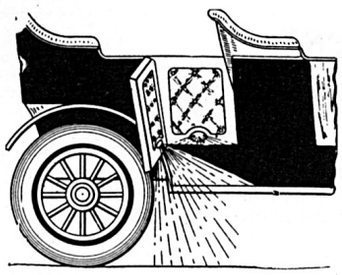
A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.
Radio Stations of, 1—Miss Edith Charmont, Cleveland, Ohio; 2—Forest Longbrake, Sheffield, Mo. Electrical Laboratories of, 3—Chas. P. McLaughlin, Cadiz, Ohio (First Prize); 4—Ralph P. Anderson, Selma, Calif.; 5—Vernon Clements, Elmwood, Nebraska; 6—Carroll Whitney, Waterloo, Iowa; 7—Frank Henninger, Pawnee, Ill.; 8—Scott E. Vance, Hillsboro, Ohio.

LATEST PATENTS

Door-Light for Autos

(No. 1,248,930; issued to Albert C. Schulz.)

An idea capable of wide application and providing electric light on the step of an auto whenever the door is opened, while the light on the closed door lights up simultaneously, and thus illuminates the

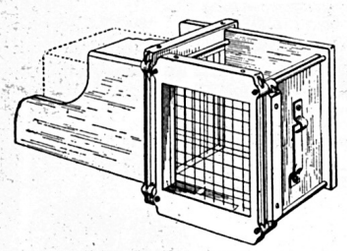


floor of the car. The lights are supplied with current from the car's storage battery or from dry cells, and are controlled by automatic switches mounted behind the doors. The circuits are inter-wired so that the lamps light in the manner above described. A glass window is placed in front of the lamp as well as underneath the lamp, so that the light shines in a horizontal plane as well as a vertical one.

Electric Ice Cutter

(No. 1,250,010; issued to Germain Pouchan.)

A clever invention intended for use in hotels, restaurants, etc., for the purpose of cutting ice into small blocks or cubes for table use. The inventor provides in this device one or more sets of wires which are heated by electricity and to be kept in contact momentarily, and thus the hot wires melt their way thru the ice. By using a suitable number

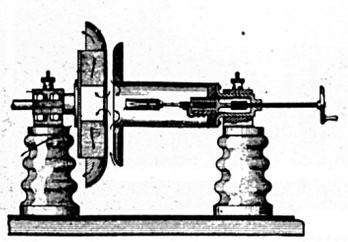


of sets of such wires, the ice may be cut in as many planes as is desirable. In cutting it into cubes, it must be cut in three planes at right angles to each other, and in this case the inventor provides three sets of parallel wires, the wires of each set to be so positioned as to cut the ice in the manner above described.

High Tension Rectifier

(No. 1,251,269; issued to A. Mulvany and E. Kennedy.)

The high tension rectifier here shown is intended particularly for use with X-ray tube circuits, for the purpose of converting high tension A.C. from the secondary of a step-up transformer into a high potential uni-directional current.

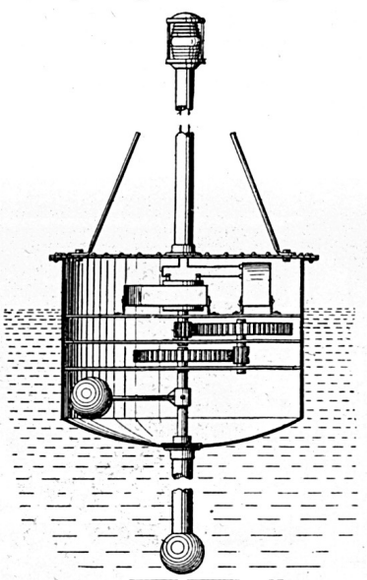


This rectifier takes advantage of the electrostatic field intensities surrounding electrodes of different

Automatic Electric-Light Buoy

(No. 1,248,850; issued to H. Hartman.)

The main object of this device is to provide an independent and automatic electric light buoy of simple construction, which can generate its own electricity for lighting a lamp at its mast head without batteries or other apparatus requiring constant or periodical maintenance. The device comprises certain mechanical features whereby motive power for driving a high tension magneto is

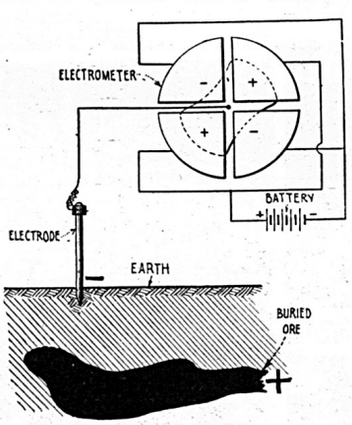


derived from the constant wave action of the sea. A heavy weight is mounted on the main shaft of the mechanism so that as the buoy pitches about on the waves, this weight follows the law of gravity and swings back and forth. The magneto is connected in series with a lamp of the Geissler tube type, and a suitable condenser.

Electric Ore Detector

(No. 1,248,380; issued to Rupert Nelson.)

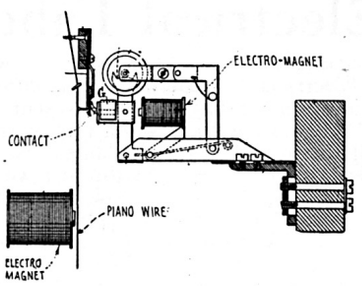
Different metals can be substituted for the electrode that is inserted



into the earth, so as to determine whether the ore is positively or negatively electrified with relation to the electrode, thus ascertaining into what class the ore belongs. The apparatus employed for the purpose includes a source of current such as a battery and a quadrant type electrometer, connected up in the manner shown. The diametrically opposite quadrants are connected to opposite sides of the battery so as to be electrified, negatively and positively respectively.

Electric Piano Player

(No. 1,249,157; issued to Alcide H. Maitre and Victor H. Gaston Martin.)

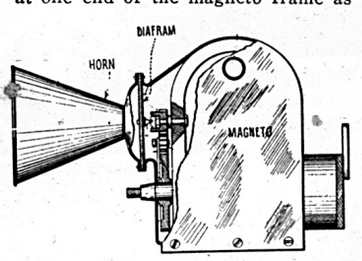


This patent deals principally with a unique electromagnetic interrupter for producing musical sounds such as by vibrating the strings of a piano or other instrument. The device is claimed to damp out false vibrations, and to suppress extraneous noises, so as to give a pure sound. The electrical interrupter contacts are subjected to the vibrations of the spring. There is also provided an independent spring pressing one of the contact members into engagement with the vibrating musical spring, so as to cause the sonorous vibrations of this string to faithfully react on the interrupter contact spring.

Combination Magneto and Horn

(No. 1,249,255; issued to H. R. Van Deventer.)

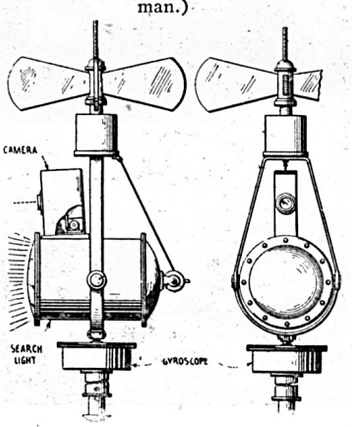
A combination dynamo or magneto and auto horn of simple design. The magneto is driven constantly as in the regular auto equipment, and the horn is mounted at one end of the magneto frame as



shown. By means of a sliding gear and a lever connected with a control rod and handle, leading up to the driver's seat, it becomes possible to bring a pinion into contact with a stud on the diafram of the horn and thus cause it to operate.

Submarine Movie Camera

(No. 1,250,582; issued to H. Hartman.)

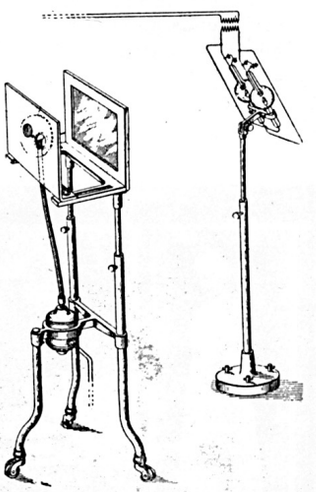


This apparatus provides for the taking of submarine motion pictures at various depths of the sea. The device is provided with electric motor stabilizer, and the various electrical features involved in the operation and orientation are controlled from the surface of the water by means of electrical conductors leading downward thru a well insulated cable. The outfit is provided with a shock absorbing member at its lower extremity in the event that the device might be lowered too rapidly in some instances.

Stereoscopic X-Ray Apparatus

(No. 1,250,093; issued to William D. Coolidge.)

The invention requires the use of two X-ray tubes, connected in a certain manner to a high tension transformer, while the successive images produced by these two X-ray tubes on a fluorescent screen are viewed in proper relation, first by

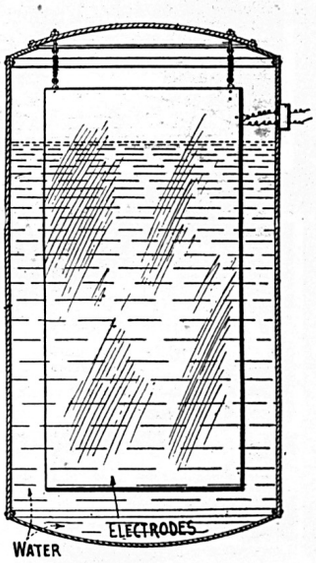


one eye of the observer and then by the other, in perfect synchronism with the current impulses so as to produce the effect of an image seen in stereoscopic relief.

Electric Boiler

(No. 1,251,116; issued to Ora E. Sarr.)

This invention appertains generally to electric boilers, and aims to provide an improved form of electrically heated steam generator, wherein steam for operating an engine or other device is produced



by the passage of an electrical current thru water, circulating around and between a series of oppositely charged electrodes in the form of metal plates, these plates being suspended in the water within the boiler. The patent covers special means for suspending the electrode plates within the boiler.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

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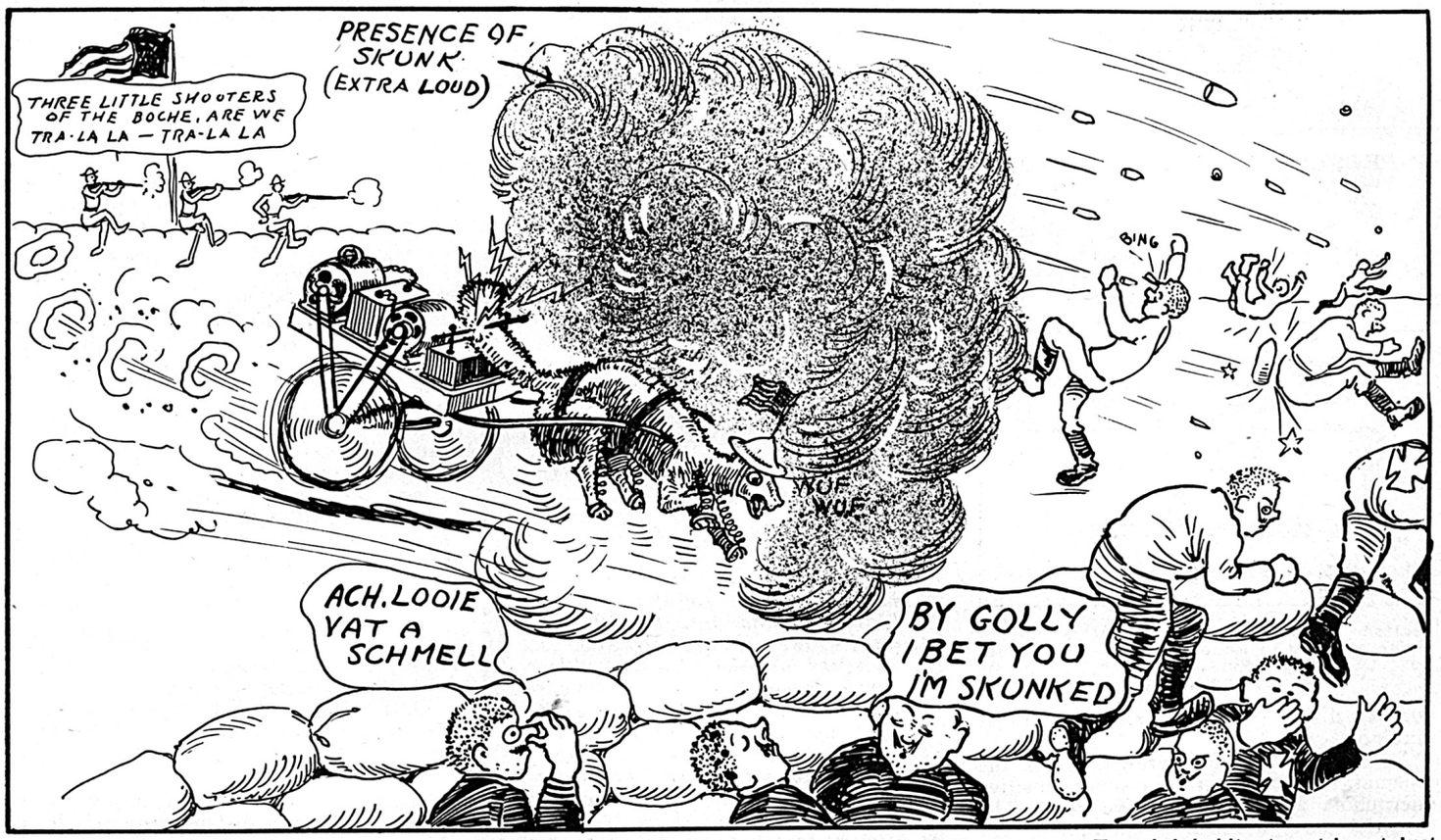
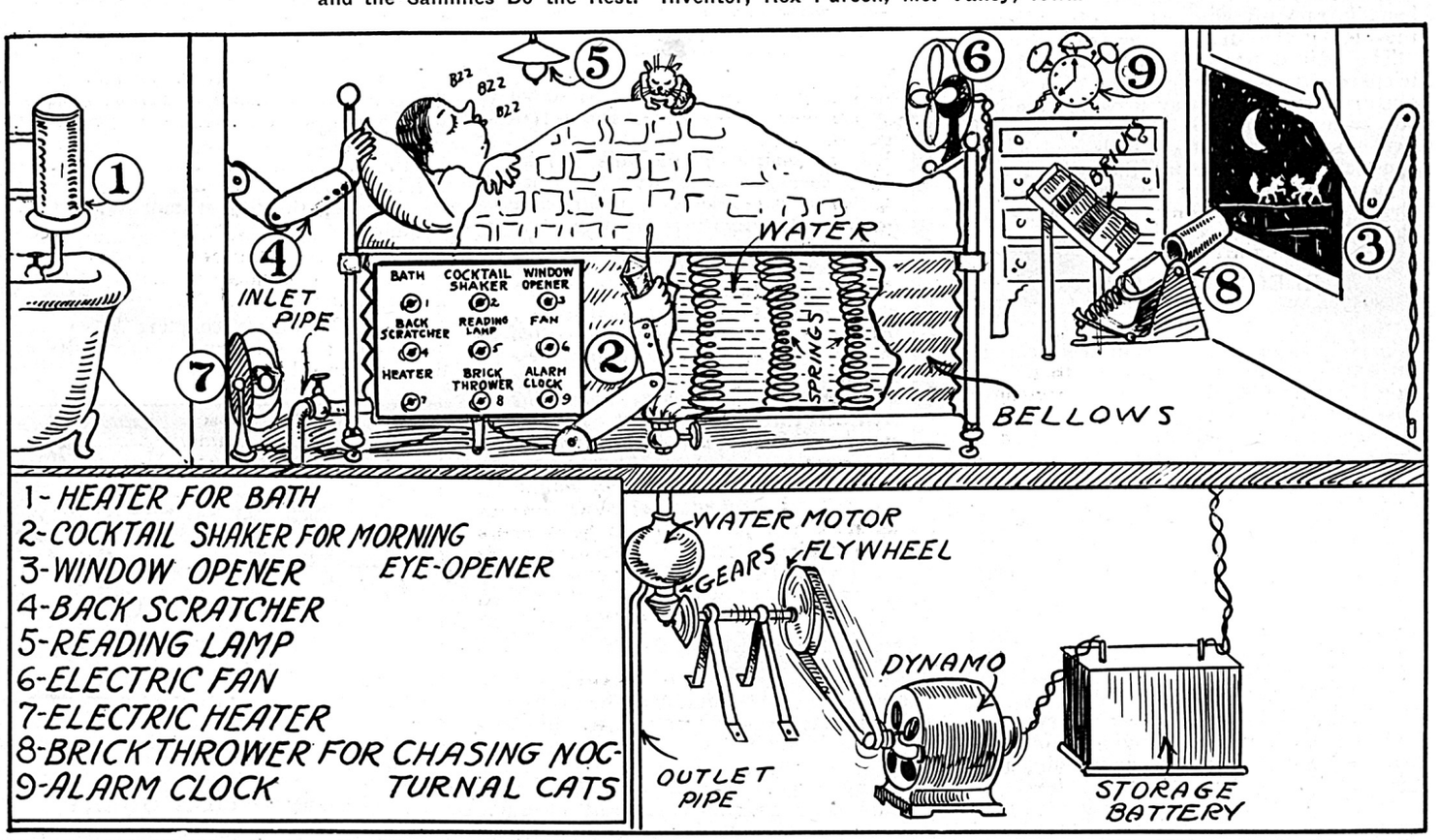
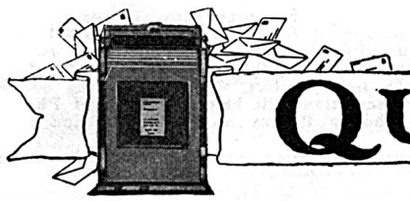


Prize Winner. SKUNK GASSER. "Well, I've Been Skunked," Will Soon Be Heard Among the European Trench Inhabitants—at Least Just as Soon as I Can Get Official Washington to Consider the Merits of My Sure-fire Hun Destroyer. Several Hundred Battalions of Tame Skunks Are Hitched to Small Two-wheeled Carts, Each Containing a Dynamo, Motor, Storage Battery, and Spark Coil. Dynamo Charges Battery, Which Runs Motor. Motor Drives Cart. Skunk Can't Stop Once Spark Tickles Him. The Limburger-lovers Are Soon "Skunked" and the Sammies Do the Rest. Inventor, Rex Purcell, Mo. Valley, Iowa.



HYDROELECTRIBED. Do You Sleep? Sure You Do! Well, Here's the Latest Convenience for All Those Who Hit the Hay, either Periodically or Regularly. Just Before Retiring, Turn on the Water-valve Suppying the "Mattress Bellows." You Rise as You Snore, and While Sleeping Produce a High Pressure in the Bellows. This Water Pressure Runs a Turbine Connected to a Dynamo. The Dynamo Charges a Storage Battery. The Latter Furnishes Electric Current Free of Charge for Electric Light, Heater, Cock-tail Mixer, Fan, Alarm Clock, Ad Lib—Ad Infinitum. What More Could Mortal Want? Inventor, John Renault, Angers, France.



QUESTION BOX

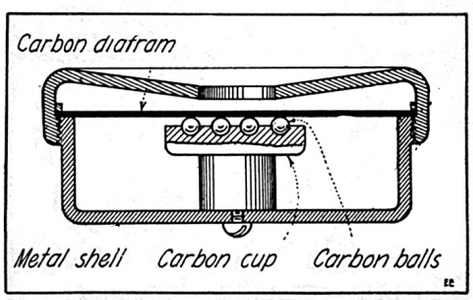
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

SUPERSENSITIVE MICROPHONE.

(894) A. E. Glazier, of Oakland, Cal., requests:

Q. 1. Will you please publish a diagram of the interior parts of the *Super-Sensitive Microphone* such as is used for detective work and explain parts of the same; how



Sectional View of Super-Sensitive Microphone as Used in Loud-Speaking Telephones For Detective Work, Interior Telephone Systems, Etc.

does it differ from the telephone transmitter?

A. 1. The diagram herewith gives the schematic arrangement of a super-sensitive microphone as used in detective work. The essential parts of such a microphone are the container, usually made out of metal, the carbon diafram and a carbon cup. A very high grade of polished carbon balls are used in this carbon container, and the carbon diafram of which is so adjusted that they touch this diafram very lightly.

The main difference between an ordinary telephone transmitter and that of a super-sensitive type is the way in which the carbon grains are utilized. In the super-sensitive microphones, carbon balls and a carbon diafram are used, together with a fairly heavy current and a low resistance telephone receiver, having a resistance of about 5 ohms.

ELECTRO-MAGNET.

(895) W. C. Mace, Marshfield, Ore., writes:

Q. 1. Please give in detail specifications for an electro-magnet necessary to pull an iron lever thru 90 degrees into a horizontal position. There is very little resistance on this lever; approximately an equivalent of three pounds' pull. I would like to know the amount of wire, size of wire, size of soft iron core and amount of current necessary. I have unlimited current.

A. 1. A suitable electro-magnet for obtaining results such as you desire is specified below: The soft iron core should consist of a soft iron bar ½ inch in diameter and 3 inches long. Fiber bobbin ends 2 inches in diameter are placed at each end of this iron core, and then fully winding the intermediate space of said bobbins with No. 22 B. & S. D. C. C. copper magnet wire, and the ends of this winding should be brought out thru two holes protruding thru the end bobbin. The winding should be carefully protected by covering it with tape. Voltage used 12 volts and current about .75 ampere.

SQUIRE'S WIRED WIRELESS.

(896) Cyril Thorn, of St. Louis, Mo., asks:

Q. 1. In number 9 of Hawkin's Electrical Guides, on page 2337, a method is explained whereby you can telephone or telegraph over a single wire, without using a return wire. It is called Squire's *Wired Wireless*. As it does not describe fully how this is done, I do not understand it, and would like to know how it works.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

A. 1. The operation of Squire's *Wired Wireless* is dependent upon the transmission of alternating currents of different (above audibility) frequencies over a single line.

Let us suppose that the equipment is to be utilized for the transmission of telegraph and telephone messages. Several telephone and telegraph stations are linked electrically to a single wire, and each of these stations are *tuned* to a separate or individual frequency. The transmitters of each of these stations are equipt with alternating current generators supplying currents of frequencies corresponding to those used in the receiving stations, so that by means of a switch one can control the frequencies very easily. When the party desires to obtain a certain station, he merely throws over the switch controlling the frequencies to the particular frequency of the desired station, and thereby he is able to communicate with said station. No two different frequency currents can interfere with each other; thus the selectivity of the system. The first station might have a frequency of 30,000 cycles per second; the second station a frequency of 33,000 cycles per second, etc., etc.

WAVE METER QUERY.

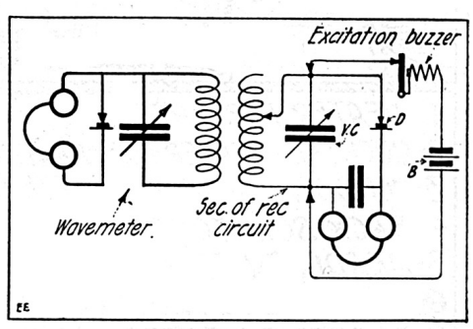
(897) John Halson, of Baltimore, Md., wishes to know:

Q. 1. How to utilize the wave meter for obtaining the wave length of a distant station.

A. 1. The manner in which you can apply the wave meter for measuring the wave length of a distant station is by arranging the apparatus as indicated in diagram. The received signal is first tuned to the required wave length of the distant station by varying the various inductances and capacities in the receiving circuit. Then by introducing a buzzer excitation circuit in the secondary circuit as indicated, and receiving this excitation current in the wave meter, resonance between the secondary and the wave meter will indicate the wave length which was originally received by the receiving set. By referring to the original calibrated curves of the wave meter the wave length of the distant station is thus obtained.

Q. 2. What causes a double humped resonance curve in an oscillatory circuit in a transmitter?

A. 2. Too close coupling between the secondary and primary circuit results in a double humped curve.



Circuits Used in Determining the Wave Length of a Received Signal By Means of the Wave-Meter.

ILLUMINATION QUERY.

(898) Paul Johnson, of Detroit, Mich., desires to know:

Q. 1. What disadvantage has a frosted glass upon an incandescent tungsten lamp?

A. 1. There are several disadvantages from using frosted glass on tungsten lamps; namely, the increase of temperature within the bulb due to multiple reflections of the irregular surfaces produced by the frosted glass, which naturally decreases the life of the filament due to the operation of the filament at higher temperatures. Secondly, the decrease of surface illumination produced by such a lamp, due to a gathering of dust in the fine irregular sections of the frosted glass.

Q. 2. What are *getters* in incandescent lamps?

A. 2. *Getters* are chemical compounds which are used to absorb the vaporized tungsten produced by the heated filament and retransferred back to the filament in order that the filament will be kept at the some thickness as it was originally. This retransformation is a chemical process, and very little is known about it, as the commercial companies are keeping it secret. However, it may be said that originally, when the incandescent lamp was begun, that halogen members of the chemical group were utilized, viz.: bromin and iodin.

Q. 3. What is a micron?

A. 3. A *micron* is the unit of intensity of illumination and is numerically equal to one one-thousandth of a millimeter.

ELECTRIC OIL AND WATER FINDER.

(899.) Mr. Phil Buracker, 828 Downing St., Denver, Colo., asks for data on:

Q. 1. A special form of "Hughes' balance" for locating underground ore, etc.

A. 1. Concerning special form of the Hughes' Induction Balance for locating metallic masses buried in the ground, etc., we would suggest that you read the article appearing in the August, 1916, issue of THE ELECTRICAL EXPERIMENTER, copy of which we can supply at 20c.

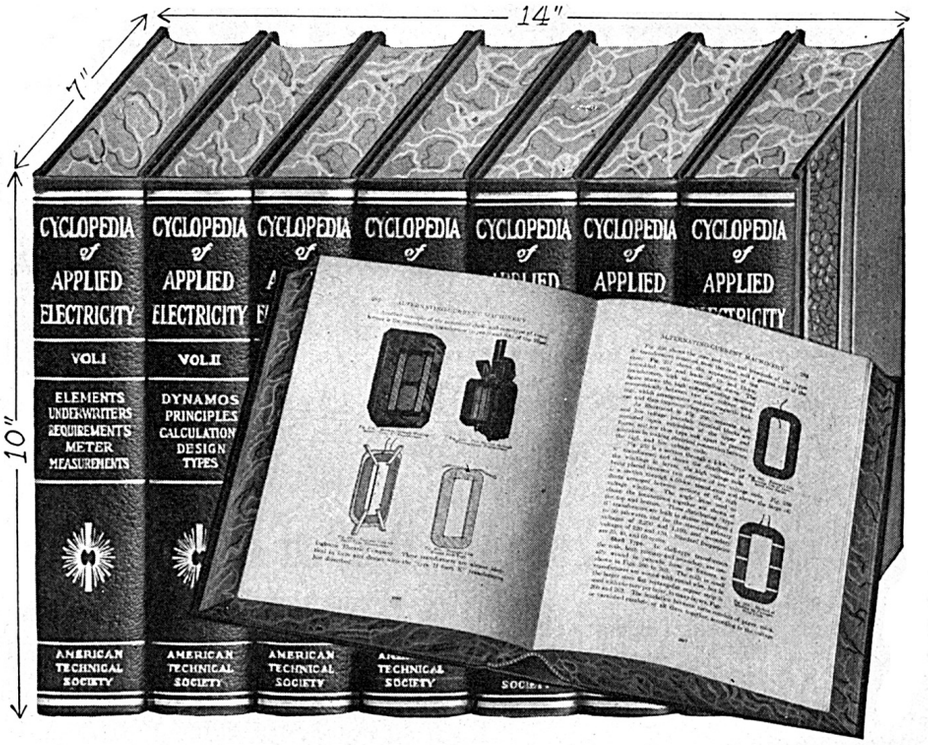
This article contains the basic principle upon which all such apparatus, of no matter what size, should be designed. With regard to the size of the inductance coil, these can be of any dimension desired, but, of course, the size of the wire and the number of turns on each coil will have to be judged by experiment to a large extent. Considering that the coils are made with a fairly large number of turns in proportion to their size, then the problem of exciting these coils properly is mostly a matter of experiment, and one which can be solved quickly.

If a buzzer fitted with an auxiliary battery contact is used as described in the article above mentioned, to excite the two primary coils of such an apparatus, then it is but necessary to increase the battery current or number of batteries in this exciting circuit thru the primary coils, and the sensitivity of the entire outfit checked up by approaching the coils with a metal mass such as an iron tank or any other metal object of fair size which may be at hand.

The diameter of the two coil bobbins or forms used on the French "shell locating" balance measure about 2½ feet in diameter, and one primary and one secondary coil are wound on each of the two bobbins, these bobbins being supported from a transverse bar carried on a light two-wheeled truck so as to be readily pushed along the ground when in use.

Q. 2. What is meant by the term "layer on layer?"

A. 2. With reference to the term "layer on layer," this simply means to follow the usual construction in winding electro-magnets or other coils and when one layer has been wound on, the second layer is wound



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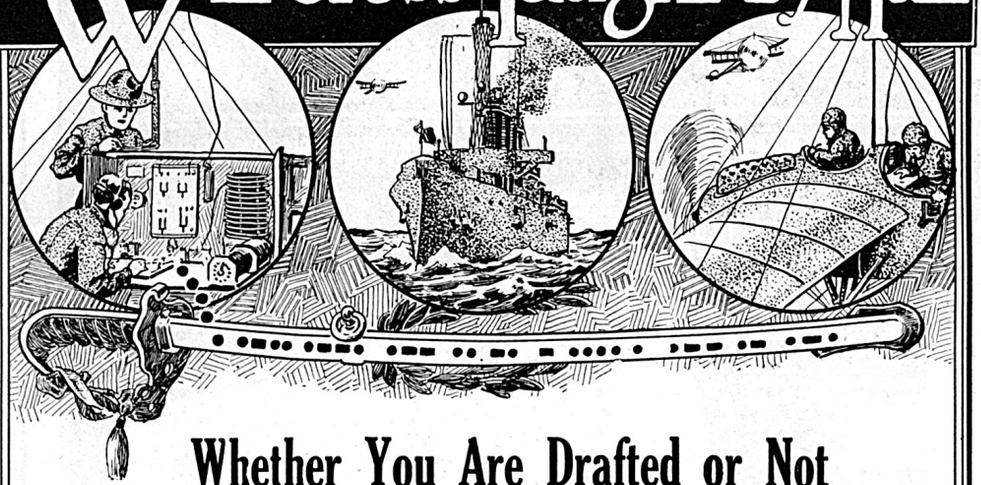

Whether You Are Drafted or Not

you cannot afford to shut your eyes to the fact that one of the most important branches of the Army, Navy or Aviation branch is WIRELESS; particularly for entering the Signal or Aviation branch of the Army. When called to the cantonment *you must know* wireless, and know it well. There is no branch requiring more trained men than the wireless section.

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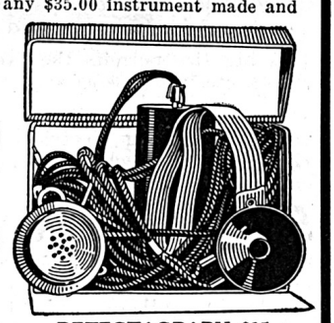

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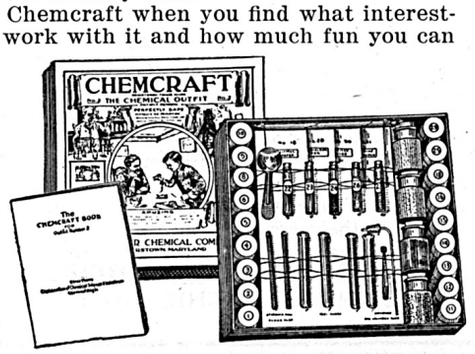


Chemcraft No. 2, Price $2.50. West of the Mississippi and Canada, $3.00.

over this in the usual manner, back and forth until the required number of turns have been placed on the coil.

Q. 3. Is there any form of electrical oil and water locater?

A. 3. Yes, an English concern has evolved a very successful electrical apparatus for this particular purpose, which has been approved and used with success by the engineers of the British government both in England and in foreign countries; particularly in India, where it has heretofore been extremely difficult to successfully locate flowing water in order to bore the necessary wells, of which a very large number exist in that country.

The principle on which the instrument works is the indicating of the presence of currents which flow between earth and atmosphere, and which, seeking the path of greatest conductivity are always strongest in the vicinity of subterranean water courses, the waters of which are charged with electricity to a certain degree.

In taking observations, wooden pegs are placed at intervals of twenty paces in a direction usually S. E. to N. W. The instrument is tried over each of these pegs in turn, and should the needle move on any one of them, tests are made all round it, and the spot where the greatest movement of the needle is obtained is where the boring should be made. If the needle does not move, subterranean water does not exist under the spot where the instrument is fixt.

The instrument indicates water courses flowing underground in a natural state, and not water pipes or sources that have sprung up to daylight. Observations should always be taken on a fine, calm, clear day between 8 and 12 in the morning and 2 and 5 in the afternoon, these being the hours of greatest activity of the vertical earth-air currents. Send us stamped and self-addrest envelope and we will gladly give you the name of the concern making this apparatus.

MISCELLANEOUS QUESTIONS.

SPECTRUM OF THE AURORA.

(900) A. D., San Francisco, Cal., writes the "Question Box":

Q. 1. Is anything positive known about the nature of heat lighting?

A. 1. With reference to the exact nature of heat lightning, nothing specific is known concerning this phenomena, but it is generally conceded that heat lightning is nothing more nor less than the reflection of powerful lightning discharges at a considerable distance.

Q. 2. (*a*) Has the spectrum of the Aurora ever been determined exactly or is it variable? (*b*) Can a gas be rendered luminous under the influence of heat alone, and if so is its spectrum identical with that of the same gas illuminated by an electric discharge in a vacuum tube? (*c*) In the event of gases not being known to be luminous under the influence of heat alone how can we explain the explosions of incandescent hydrogen witnessed during total solar eclipses, and how can we explain the illumination of gases in neubulae? (*d*) Are there such things as phosphorescent gases?

A. 2. (*a*) The spectrum of the Aurora has been measured by different investigators, but owing to the rapid and sudden changes in the coloring as well as the extent of the Aurora the spectrum varies likewise. However, several interesting points have been discovered in this direction, particularly in regard to the presence of certain rare gases in the upper region of the Aurora.

(*b*) It is possible to make a gas luminous under the influence of heat alone,

and the degree of luminosity depends upon the pressure of the gas due to its expansion, etc. The spectrum of this illuminated gas is the same as when excited by any other means, such as by the application of electric current.

(*c*) The explosions of incandescent hydrogen witnessed during total solar eclipses, and also the illumination of gases in nebulae are undoubtedly due to the presence of nascent hydrogen and also oxygen, which by the electrical disturbances occuring in these gases cause sudden molecular explosions. This is most probably due to the electrical bombardments of the gaseous ions, this causing the gas to become luminous.

(*d*) So far as we know there is no such thing as a phosphorescent gas.

Q. 3. (*a*) Where can I buy a book treating such subjects as unipolar lamps illuminated by High Frequency Currents; Fleming valves, Cooper-Hewitt lamps used as valves and vacuum tubes containing three electrodes used as detectors for Hertzian waves. (*b*) In the study of selective reflection there is a point I fail to grasp. We are informed that certain substances possess systems which vibrate with well defined periods. These systems reflect light falling on the substance only when the incident light is of the same frequency and in this case reflect it totally, producing the phenomenon of *selective reflection*. We further know that when these natural periods of vibration reside in the infra-red the vibrating system is no longer an electron but a *molecule*. Now a molecule is generally neutral as opposed to an electron, which is negative electricity.

How then can the vibration of a neutral molecule reflect light since reflection is due to the radiation produced by vibrating electrons? Are we to suppose that neutral molecules can radiate energy when in vibratory motion, or are we to suppose the molecules cease to be neutral when vibrating?

A. 3. (*a*) We would recommend Dr. Nikola Tesla's book entitled "Experiments with Currents of High Frequency and Potential" which contains much valuable information on unipolar lamps lighted by high frequency currents, etc. For information concerning the Fleming valve and other valves of similar type, we would recommend that you consult any of the modern hand-books on Radio-telegraphy, including the excellent work of Dr. J. A. Fleming, which we can supply at $10 net. An exhaustive article describing the exact mode of operation of the Audion appeared in the August, 1916, issue of THE ELECTRICAL EXPERIMENTER, page 251, and which is one of the most authoritative that has appeared on the subject, the article having been past upon by Dr. de Forest and several other leading experts on this class of device.

(*b*) This is a somewhat complex subject and we would suggest if you have not already consulted back issues of the General Electric Review that you would do well to look up some very interesting articles on the subject of selective reflection which appeared therein about one year ago.

In general, it would seem reasonable to suppose that the molecules in a certain structure cease to be neutral when they are set into vibration by the application of some external means, such as by the rays from an X-ray tube or by ultra-violet light from a spark gap, arc light, etc.

You will find it worth your while to consult several of the newer books treating on molecular structure, and we take pleasure in suggesting one of the very latest works in this direction entitled "The Electron—Its Isolation and Measurement and the Determination of Some of Its Properties," by Prof. Robert A. Millikan, one of the foremost scientists in this branch of philosophical research. Our "Book Department" can supply a copy of this book at $1.60 prepaid.

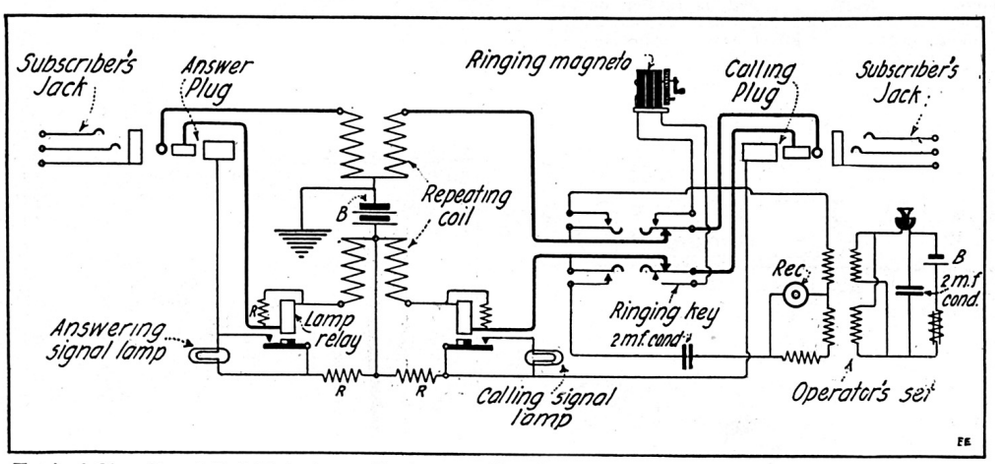
THE BELL TELEPHONE SYSTEM.

(901.) L. Slack, of Pittsburgh, Pa., asks:

Q. 1. Kindly give me some information as to the external and internal wiring of the Bell Telephone System.

A. 1. It would be impossible for us to give you full details, and especially a complete wiring diagram, of the Bell Telephone System in this column.

However, we are herewith giving you part of the circuit as used in the central exchange. It shows clearly how the various repeating and retardation coils are used.



Typical Circuits of Bell Telephone Exchange, Showing Position of Repeating and Retardation Coils, Lamp Call Signals, Et Cetera.

TELEPHONE RELAYS.

(902.) J. H. Wood, Iowa, asks:

Q. 1. What is the state of the work now done by the telephone relay?

A. 1. The Bell Telephone Co. is now using a very successful form of telephone relay of the Audion type on their long distance lines, between the eastern and western coasts. If you talk from New York to San Francisco, your "voice" passes thru one of these Audion relays.

Also the "Brown" Microphonic Relay has been used quite successfully in England for several years in telephone and other work. There have been many patents taken out in the past few years on electro-magnetic forms of telephone relay, and if you are intending to carry out research work on this device, we would strongly suggest that you have a patent attorney make search of the patent office records, and furnish you with copies of all of these patents taken out in recent years.

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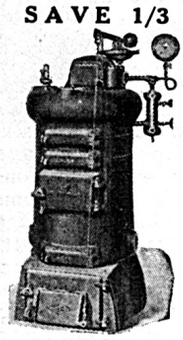

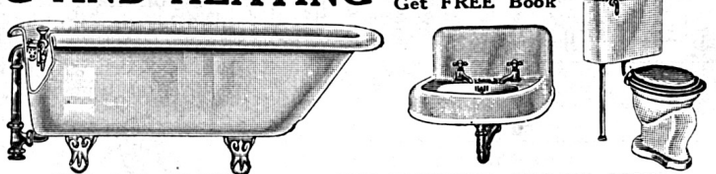

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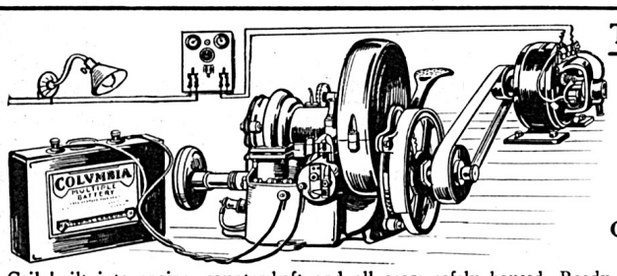

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COST OF RUNNING ELECTRIC LAMP.

(903.) G. H. B., New York, inquiries:

Q. 1. How many kilowatt-hours will a 25 watt, 110 volt, Mazda lamp consume, burning 31 days continuously and what will it cost to operate?

A. 1. A 25 watt, 110 volt Mazda tungsten lamp, burning continuously for 31 days will consume 18.6 K. W. hours of electrical energy and at 10c per K. W. H. your bill for this lamp would be $1.86. This is computed as follows: The 25 watt lamp would consume .025 K. W. H. per hour (25 ÷ 1,000, as there are 1,000 watts per hour to 1 K W. H.); then .025 × 24 × 31 = 18.6 K. W. H. in 31 days. At 10c per K. W. H. the bill figures out at $1.86 (18.6 × $0.10 = $1.86).

PROCEEDINGS OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

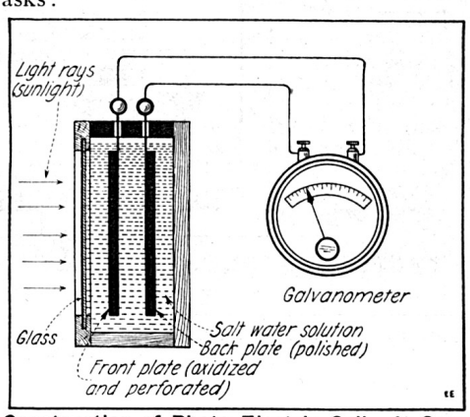
(904.) J. E. Cartinill, W. Va., wants to know:

Q. 1. Where he can procure the American Institute of Electrical Engineers' proceedings.

A. 1. You may procure copies of the proceedings of the American Institute of Electrical Engineers by writing to the Secretary, Mr. F. L. Hutchinson, c/o the Institute, 33 West 39th Street, New York City, and the monthly Proceedings are worth $1 a copy.

PHOTO-ELECTRIC CELLS.

(905.) T. T. Gentry, Lexington, Ky., asks:



Construction of Photo-Electric Cell. It Generates Electricity When Light Strikes It.

Q. 1. How to construct a photo-electric cell?

A. 1. Regarding the construction of light-sensitive copper oxid (photo-electric) cells, these are usually constructed of two thin copper plates immersed in a salt water solution, one of the plates (front one) being blackened by oxidation over a gas or other flame, and the other (back plate) remaining polished. A sensitive galvanometer can be connected across the two plates, and when light is thrown on the cell, the galvanometer will be deflected.

Refer to the September, 1916, issue of this journal, page 316, where extensive technical data is given on such cells. In one type tried out and there described in detail, the voltage produced in strong sunlight was 1/10 volt and the current about 1—2,000 ampere. This was with a small cell having plates but 3 by 4 inches.

It was found that if the cell was left short-circuited in the dark while not in use, the efficiency of the light reaction would then be greater upon exposure than when left open-circuited while not in use. Upon exposure of the front plate to light the electronic reaction is practically instantaneous. The electronic flow with light on is from the rear plate to the front plate; the current flow from the front to the rear plate.

ARC LIGHTS VS. SERIES INCANDESCENT LAMPS.

(907.) W. D——, inquires:

Q. 1. As to relative charges which should be made for series incandescent lamps in place of arc lamps for street lighting?

A. 1. In the first place, we cannot give you the exact data desired as we do not know the total watts consumed by the 600 C. P. 4.4 ampere series arc lamp mentioned.

Figuring, however, on 70 volts per series arc lamp and with a current of 4.4 amperes you would obtain a total consumption of 308 watts per arc.

The inverse ratio between the 100 watt series incandescent lamp and the 308-watt arc lamp is therefore 32.45 per cent, and this percentage of 87.50 (the rate per annum for the arc) gives $28.42 per annum as the equivalent rate which should be paid for the 100 watt series incandescent lamp, considering the same base price per k.w. hour.

Speaking in a general way and without knowing any of the details governing the operating conditions of your local electric light company, we would advise that the series incandescent will prove the least expensive with regard to maintenance as compared to the arc lights. It is our opinion that the method of computing the equivalent rate to be paid by the city for incandescent series lamps as above outlined is not fair in all cases, owing to the fact that the electric light company may be operating under much less favorable conditions in your city as compared to the operating conditions in the other city.

BAROMETER QUERY.

(908.) Guy B. Admire, Missouri, asks:

Q. 1. See first experiment at Fig. 1, right; a partial vacuum is produced at the top of the tube. Say the atmospheric pressure pressing down raises the water in this tube 15 inches. But in the second experiment there are 2 square inches instead of one; would it raise water 30 inches in this tube?

A. 1. In reply to your query concerning the height of a liquid in a barometer tube, would say that this is a function which depends upon the atmospheric pressure and upon the density of the liquid in the barometer tube, and has nothing to do whatsoever with the cross-sectional area of the tube itself.

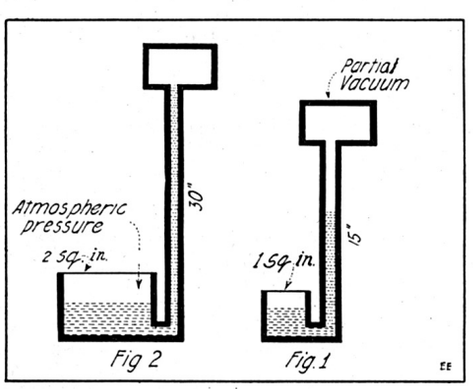


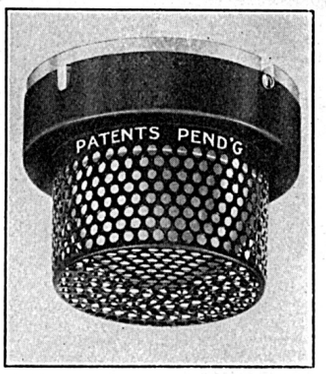
Diagram Illustrating Querist's Problem, in Which He Asks if Greater Area at Base of Barometer Does Not Cause Greater Height of Liquid to Be Supported as Shown.

At sea level the atmospheric pressure will support roughly about thirty inches of mercury or about 34 feet of water.

A new pocket lamp, which carries its own electric generating plant and requires no dry battery renewals, remains lighted as long as the dynamo is kept in motion by a lever operated by the thumb.

NEW AUTOMATIC FIRE DETECTOR.

This new electric fire detector is a compact little device to be used in either dwellings, factories or warehouses, piers, etc., to give warning, by means of any alarms or annunciator system to which it may be connected, of a fire in its early stages so that a fire extinguishing equipment can be brought into use before the fire passes beyond the first critical few minutes. It gives an alarm in ten to thirty seconds; automatically adjusting itself to the usual changes of temperature occurring within the enclosure in which it is located. One detector will take care of 300 to 500 square feet. The device is thoroly protected against injury by a guard, which is placed over the sensitive portions.



Simple Form of Electric Fire Detector Operating Upon the Principle That Air, When Heated, Rapidly Expands. This Causes the Device to Close an Alarm Circuit.

These detectors may be put in with one or more on a circuit on their own independent system or they may be connected to the present call-bell system, or they may be connected, by use of an auxiliary fire-alarm box, to the present fire alarm service in the building. In private installations, the wiring is not influenced by regulations or unusual requirements; the ordinary bell wiring properly protected against injury is sufficient, as only battery current is used, or it may be installed with a complete system of annunciators and fire alarm bells, either with or without the wiring under constant supervision. This system may be connected to any manual fire alarm system by an auxiliary transmitting fire box, thus making the present system automatic.

The detector consist of a hemispherical air reservoir, the flat side or top of which is formed by a flexible diafram. This reservoir contains air at atmospheric pressure and when the surrounding atmosphere rises in temperature quickly, the dome, which is a rapid conductor, becomes heated and expands the air in it, causing the diafram to project outwardly and close an electrical contact, which acts as a switch closing the circuit of whatever fire alarm system it is connected with. To prevent false alarms being turned in by the natural changes of temperature within the enclosure in which the detector is located, a compensator is made part of the device.

NEW RADIO RECORD.

It is reported that just recently the Marconi wireless plant at New Brunswick, N. J., "picked up" a message from the Cavite naval base, on the Philippine Islands, adjoining the city of Manila, a distance of 10,000 miles. But Tuckerton comes to the front with a longer reach than that, the report being that several times this fall and winter, messages have been grasped out of the air that were sent from New Zealand, just about the antipodes from us.

YOU MIND WANDERER!

CONCENTRATION of mind, of effort, is a great factor in your endeavor and no one can successfully concentrate and apply himself if his body is not in perfect health. The mind would reflect the ailing condition of his body and impair his ability.

If you are only 50% of the man you ought to be; if you have let your vitality ebb away without cultivating the resources within you; if you have let yourself run down physically until it affects you mentally; you have been neglectful of your bodily needs. You well know that a weak debilitated system affects the memory, destroys your ambition, makes you unequal to any task and compels you to drag along in a listless fashion.

I will put your efficiency up to the notch where it ought to be; no matter what your condition now is or your position; I will make you once more gain a keen, vivid relish for work and pleasure and enable you to have such control of your mind that every good thought, instead of going to waste, you can cash in on.

I will make you vital, vigorous, snappy, energetic, enthusiastic—ambitious; I will make you do more with less effort; I will make you feel the tingle of rich, red blood flowing in your veins; I will make you feel the thrill of your nature and increase your life; I will make you splendidly healthy, strong, virile, physically able, mentally capable, better in body, better in mind—all distressing results of youthful folly will be nullified and will vanish.

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It will regain for you the powers you lost, or attain for you powers you never possessed. It will restore your vitality. It will make you realize the life that is worth living.

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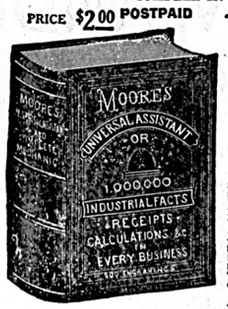

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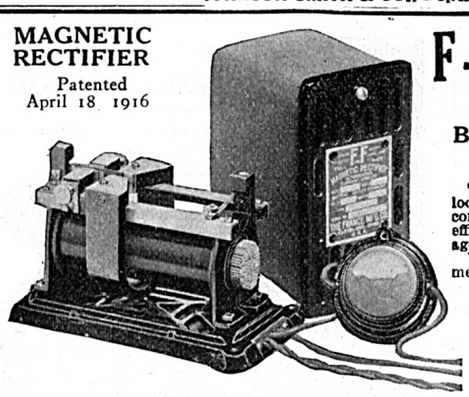

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TELEPHONING TELEGRAMS.

Conservation is the watchword of the hour. Telegraph as well as telephone companies are losing experts by the thousands to the United States Government, which has urgent need of their services. This has resulted in many branch telegraph offices being placed in the hands of persons who are not expert telegraph operators. In many cases the business handled is transmitted to main telegraph offices by telephone, and it is important that the method of transmitting uncommon words, unusual names, code words, cipher words, unpronounceable words and words in foreign languages, when passing initials or when spelling in the customary manner, should be standardized; that is to say, the same method of transmitting an unpronounceable word over a telephone circuit should be the same in all sections of the country.

The traffic department of the Western Union Telegraph Company has authorized the use of the following method for telephoning difficult words and names, which ought to be made standard thruout the entire service:

First, pronounce each letter; then, follow with the corresponding identifying word given in the list below, and as illustrated in the example:

A for Adams	N for New York
B for Boston	O for Ocean
C for Chicago	P for Peter
D for Denver	Q for Queen
E for Edward	R for Robert
F for Frank	S for Sugar
G for George	T for Thomas
H for Henry	U for Union
I for Ida	V for Victor
J for John	W for William
K for King	X for X Ray
L for Lincoln	Y for Young
M for Mary	Z for Zero

EXAMPLE: If the name "B. C. Dvorak" is to be transmitted, telephone employes shall pronounce the name and then say "B for Boston" and pause, "C for Chicago" and pause, "D for Denver," "V for Victor," "O for Ocean," "R for Robert," "A for Adams," "K for King."

MARCONI PRAISES AMERICA.

Senator Guglielmo Marconi, who has been appointed head of the Italian permanent mission in America, made the following remarks recently in addressing the Italian senate on Italo-American relations:

"The Italian mission to the United States again realized during its journey the great friendship and sympathy existing there for us and the great assistance the United States is ready to give us.

"The friendly feeling and concrete measures adopted by the American people in favor of Italy deserve our entire gratitude. We must consider the spontaneous American intervention in the war with special satisfaction."

CALIF. ELECTRIC PLANTS TO COMBINE.

Representatives of electric light, heat and power plants serving 38 counties in northern and central California have agreed to allow their electric generating plants, both hydro-electric and steam, to be operated under one head, it was announced recently.

P. M. Downing, chief engineer of the electrical department of the Pacific Gas and Electric company, it was announced, has been selected to have full charge of all of the plants with authority to carry out their efficient operation with rigid economy of fuel oil, and to cease the operation of as many of the steam plants as may be found compatible with proper service.

This plan is to be carried into force and effect at once, and to continue for the duration of the war and during such further time as would be deemed in the best interests of the public.

SUBSTITUTE FOR THE LECLANCHE CELL.

According to the *Bulletin de la Société d' Encouragement pour l'Industrie Nationale,* Prof. Féry describes a new type of wet primary cell that he has elaborated. The Leclanché cell, depolarized by manganese dioxid, is the most common type at the present day. Prof. Féry conceived the idea of doing without manganese dioxid and depolarizing the cell with the oxygen of the air. Hitherto, attempts in this direction had not met with much success owing to the zinc electrode being vertical in position, giving rise to certain disadvantages.

To overcome these defects, and use the air as the depolarizer, Prof Féry has given the zinc electrode the form of a horizontal plate placed at the bottom of the cell. The carbon electrode is vertical, being separated from the zinc by a thin sheet of felt or an ebonite cross piece.

Local action in a cell of this type is practically eliminated, and the quantity of zinc dissolved is 1.24 grammes per ampere-hour. The voltage on open circuit is 1.18.

SUNDAYS AND THURSDAYS SET ASIDE AS "LIGHTLESS NIGHTS."

To further conserve coal and other fuels, the United States Fuel Administration, amending its former orders permitting the restricted nightly operation of electric signs and displays, has now put into effect a schedule of "lightless nights" on Sunday and Thursday of each week.

Under the new order, it is forbidden to consume coal, oil, gas or other fuel for illuminating or displaying advertisements, notices, announcements or signs designating the location of an office or place of business, or the nature of any business, for electric searchlights, or for external illumination for ornamentation of any building, or lights in the interior of stores, offices or other places of business when such stores are not open for business, excepting such lights as are necessary for the public safety or as are required by law; nor for excessive street lighting intended for display or advertising purposes, whether such lights are maintained by the municipality or others.

Dr. Garfield, Fuel Administrator, has also requested that, in compliance with the patriotic spirit of the order, householders shall observe the "lightless nights" by burning as few lights in homes as it is possible to get along with conveniently.

WIRES TO RUSSIA ARE SEVERED.

Cable and telegraph lines to Russia have been cut, American Minister Morris, at Stockholm, reported on January 29th, and the only remaining routes of communication with Petrograd now are thru Persia and Vladivostok. The land telegraph lines were severed, Mr. Morris reported, at Haparanda and the cables at Viborg. He gave no indication of the significance.

BIG POWER PLANT AT NIAGARA IS PROPOSED.

Three bills designed to provide for the construction by the State of a hydro-electric plant on Goat Island, Niagara Falls, were introduced in the Legislature at Albany, on January 16th, by Senator Gibbs of Buffalo. Provision would be made for a bond issue of $3,000,000 if the measure should be approved by the voters at the Fall election. As proposed by the bill, the plant would be operated either under State management or by lease, and would be capable of generating 500,000 horse power.

ELECTRICAL MACHINERY, by Terrell Croft. First Edition, cloth bound, 318 pages; numerous illustrations; 5½ x 8½ inches. Price $2.00. Publisht by McGraw-Hill Book Co., New York, 1917.

Another work from this author of practical electrical books and one that will be thoroly appreciated by the practical man. The many chapters and sub-divisions cover all phases of electrical machinery that one constantly comes in contact with. Practical applications and theories have been arranged side by side so that the student, as well as the advanced worker, is able by means of the diagrams and explanations to grasp the essentials of modern electrical practise. A comprehensive idea of its scope may be gained from the following list of chapters:

Principles, Construction and Characteristics of Direct-Current Generators and Motors; Management of Direct Current Generators, Starting and Controlling Devices for D. C. Motors; Troubles and Testing of D. C. Generators and Motors; Principles, Construction and Characteristics of Alternating-Current Generators; Management of Generators; Induction and Repulsion Motors; Synchronous Motors and Condensers; Management of and Starting and Controlling Devices for A. C. Motors; Troubles and Testing of A. C. Generators and Motors.

A truly motor and generator book, and one which will find a ready welcome by all electrical men.

PERPETUAL MOTION, by Percy Verance. Cloth bound; 360 pages; illustrated; 5½ x 8 inches. Price $2.00. Publisht by Enlightment Specialty Co., St. Louis, Mo.

A very excellent work on a much discust subject. For centuries the struggle for the means of self-motive power has progrest and yet today in the Twentieth Century we are as far as ever away from the solution.

The numerous chapters cover a wide range, giving data on most of the known attempts at perpetual motion. The vast history of the subject has been boiled down and a comprehensive digest given, on the different methods by which various scholars sought the solution to the problem. Also chapters on why the various devices failed Among some of the more important chapters may be noted the following:

Devices intended to operate by means of Wheels and Weights; Devices employing Rolling Weights and Inclined Planes; Hydraulic and Hydro-Mechanical Devices; Magnetic Devices; Liquid Air as a Means of Perpetual Motion; Radio and Radio-Active Substances; List of Numerous Inventors and Their Devices and a final chapter on whether the question will ever be answered, besides discussions and opinions of eminent scientists on the subject.

A book for all interested in Mechanics, and those who have a strong mechanical bent. This book does not contain any new matter, but aims rather to provide a fairly broad digest of the principal perpetual motion schemes proposed from time to time in the world's history. It will prove interesting reading for all those interested in the subject from the layman's viewpoint, the treatment being non-mathematical.

RADIOTELEGRAPHY—War Department, Office of the Chief Signal Officer, Paper Covered, 6 x 9 inches, 135 pages, price 30 cents. Publisht by Government Printing Office, Washington, D. C., 1917.

A very handy book which should find a great many friends among radio men. Into this small volume has been compiled all the chief points of radio equipment, formulas and calculations such as one expects to find only in a more expensive book.

The work starts with the fundamental principles of electric charges, static fields, currents, magnetic fields, etc., and then branches out into power circuits, calculations and the functions of the various instruments, with many curves and illustrations which are of great help in mastering the art.

Considerable space is devoted to hook-ups of all standards sets as used by the U. S. Signal Corps, with notes on gasoline motor sets and complete operating instructions.

Several chapters dealing with wave meters, tuning, damping and decrement are very thoro, enabling the uninitiated to grasp the calculations of radio quantities very readily.

All in all it is a very handy manual, well worth the trifling sum asked for it and should find a ready demand from "Radio-bugs" as well as professionals.

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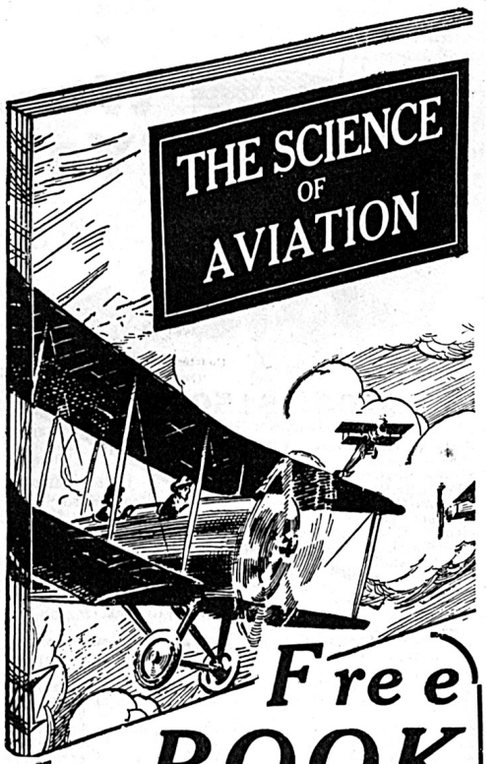

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EXAMPLES IN BATTERY ENGINEERING, by Prof. F. E. Austin. Cloth bound, 5 x 7¾"; pocket size; 90 pages. Price $1.25. Publisht by the author at Hanover, N. H., 1917.

Another very good book by Prof. Austin is this latest pocket manual on Battery Engineering. Usually very little space is devoted to this important subject in electrical text-books and it is only touched on lightly.

The increasing application of primary and storage cells and the greatly extended adaptations possible in the near future form valid reasons why battery students and engineers should have an adequate knowledge of the principles of "battery engineering."

The work covers all the working theories and practical applications in a series of lessons covering the same in easy and gradual steps. The importance of chemistry is treated on, as it has much to do with the final success of the materials involved, etc.

Many practical formulas and examples are given for calculating internal resistance, heat losses, electro-motive-force, amperage, efficiency, etc. Various arrangements of battery circuits are also given.

It is a good book for all electrical and radio students and is of particular interest now, especially as storage batteries are being adopted more widely every day to automobiles, aeroplanes, submarines and radio equipments.

NOVEL ELECTRIC TARGET.

To enable a rifleman to see where his bullets go an Ohio inventor has designed a target which, when hit, extinguishes lights in front of it and shows a light from the back thru the bullet hole.

3,000,000 H. P. AVAILABLE AT NIAGARA WOULD SAVE COAL.

(*Continued from page* 753)

a large user of sulfuric acid, increased its demand fifteen times normal since the beginning of the war.

"Where will this important industry obtain the power necessary to meet this vast demand? Electric power enters into the cost of these products varying from two per cent to 60 per cent. The cost of ferro silicon, for example, is about 50 per cent power. Hence its cost must be kept at a minimum. It must be kept at a minimum because we are in direct competition with foreign countries where the governments insist on a *complete development of the water power resources* and where real constructive legislation is used to aid the cause of conservation. Conservation by the way that is conservation, and not a plank in a political platform.

"There are but two sources of power: First, coal; second, water. Daily we read headlines complaining of 'shortage of fuel.' The most optimistic prognosticators tell us the mines will disgorge but little over their usual amount this year. Decreased labor supply is not the only cause of the shortage. It is well known that every ton of steel requires a ton of coal in its manufacture. The production of steel is without precedent, and so its consumption of coal. Our mighty effort should be to prevent additional uses of coal and in fact diminish the domestic consumption in favor of the steel industry. Even if it were possible to obtain coal at prices permitting steam-electric developments, the apparatus for this purpose could not be obtained in less than three to four years. The war program of this country is such that the total capacity of the manufacturers building this class of apparatus has been requisitioned for that length of time which may even be extended. The shortage of power menace is with us now and its solution must be obtained in far less time than that to save us from a desperate serious embarrassment of our war program. Therefore, we cannot look to steam to solve the power problem. Evidently our only lasting salvation is in water power.

"Water power can be divided into two zones: western and eastern. The bulk of the eastern power is located at Niagara Falls, a potential possibility of perhaps 6,000,000 horse-power, 3,000,000 available without affecting its scenic grandeur. We have heard the great exponents of western power proclaim that if there is a shortage of power in the east, come to the west, where there are some 13,000,000 horse-power undeveloped at the present time. This power could be developed at a cost to permit a selling price equivalent to Niagara power some five or ten years ago. But is power located so far from the industry's center of gravity cheap at any price?

"The electrochemical industries at Niagara Falls consumed practically all of the power developed on the American side (approximately 250,000 horsepower) plus approximately 150,000 horsepower imported from Canada before the outbreak of the war. Owing to the increased activities on the Canadian side, the Canadian government has found it necessary to exercise certain rights which it retained, and a great percentage of the power coming to this country from Canada has been cut off. The industries, therefore, at the falls find themselves in the predicament of having installed equipment, but no power to operate it. It is doubtful if at the present time 70 per cent of the installed equipment at Niagara Falls is under power. In other words, the plants are not turning out as much today as they were previous to the war. It was found necessary in Buffalo, but 20 miles away, to build a steam plant of 120,000 horsepower. This being a public service corporation, it was necessary to produce power regardless of the cost, but when a mobile industry is affected, there is nothing for it to do but move and this is happening.

"The best hydraulic talent in America advises us, that it is possible to develop at Niagara Falls 3,000,000 *horsepower* without in the least affecting the scenic grandeur of the most wonderful cataract in the world. By the proper location of submerged dams, the rapid deterioration of the Horseshoe Falls would be eliminated and the certain suicide of this wonderful cataract stopt.

"The crest of the Horseshoe Falls is moving back at the rate of seven feet a year. The length of the crest in 1842 was 2,030 feet and now has increased to 3,020 feet. The farther back the erosion goes the more rapid it becomes. At the present rate, the Horseshoe Falls will be completely eliminated in the next two or three generations and we will have nothing but a *rapids* to replace the same. The installation of the above mentioned dams would then, therefore, accomplish a double benefit; that is, preserve the beauty of the falls together with developing half of this potential power. Some have asked for the use of water as limited by the Burton treaty, i. e., 36,000 cubic feet per second on the Canadian side and 20,000 cubic feet per second on the American side, but this is simply a drop in the bucket and would in no way affect the serious power shortage that now tends to ruin one of our most promising industries to say nothing of embarrassing our entire manufacturing position.

"Engineers have calculated that to develop 3,000,000 horsepower at Niagara Falls would save for posterity 100 tons of coal per minute or 52,000,000 tons of coal per year, sufficient to change the situation from a *shortage* to a *surplus* in the coal industry. Furthermore, it would assist in the freight car shortage, releasing 62,000 cars for use elsewhere, thereby changing the situation again from a shortage to a surplus."

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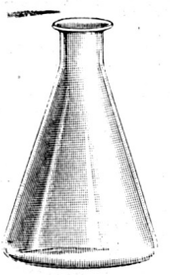

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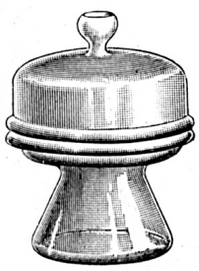

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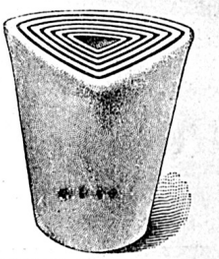
Acid Hydrochloric (Muriatic)	lb.	0.45	Ether	lb.	0.90
Acid Nitric ch. pure	lb.	0.45	Formaldehyde, tech. (Formalin)	lb.	0.80
Acid Oxalic, tech.	½ lb.	0.80	Glycerine ch. pure	½ lb.	0.90
Acid Sulphuric ch. pure	lb.	0.45	Hydrogen Peroxide, tech	lb.	0.45
Alcohol denatured	lb.	0.55	Iodine, Resublimed	oz.	0.75
Alcohol, Wood, refined 95% (Methyl)	lb.	0.50	Iron Chloride (Ferric)	lb.	0.45
Ammonia, concentr. (Hydroxide)	lb.	0.50	Iron Sulphate, tech	lb.	0.40
Ammonium Carbonate, tech.	lb.	0.45	Lead Acetate, tech.	lb.	0.80
Ammonium Chloride (Sal) tech.	lb.	0.50	Lead Nitrate, tech.	lb.	0.95
Barium Chloride, tech	lb.	0.70	Litmus Paper, blue	book @	0.10
Calcium Chloride	lb.	0.25	Litmus Paper, red	book @	0.10
Calcium Sulphate	lb.	0.25	Manganese Dioxide, tech	lb.	0.85
Chloroform U.S.P.	½ lb.	0.90	Mercuric Chloride	½ lb.	0.65

No. 2133 Wash Bottle $0.85



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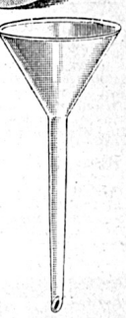

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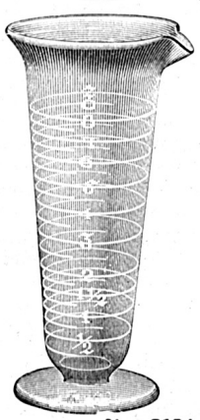

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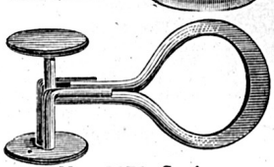

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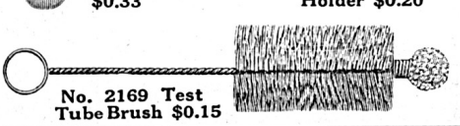

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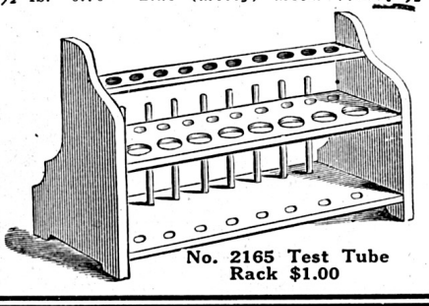

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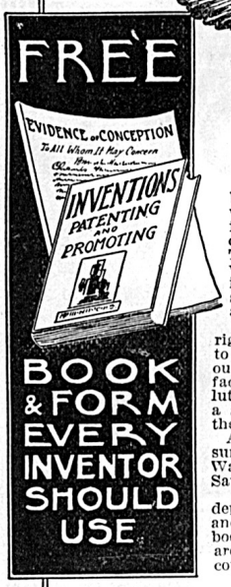

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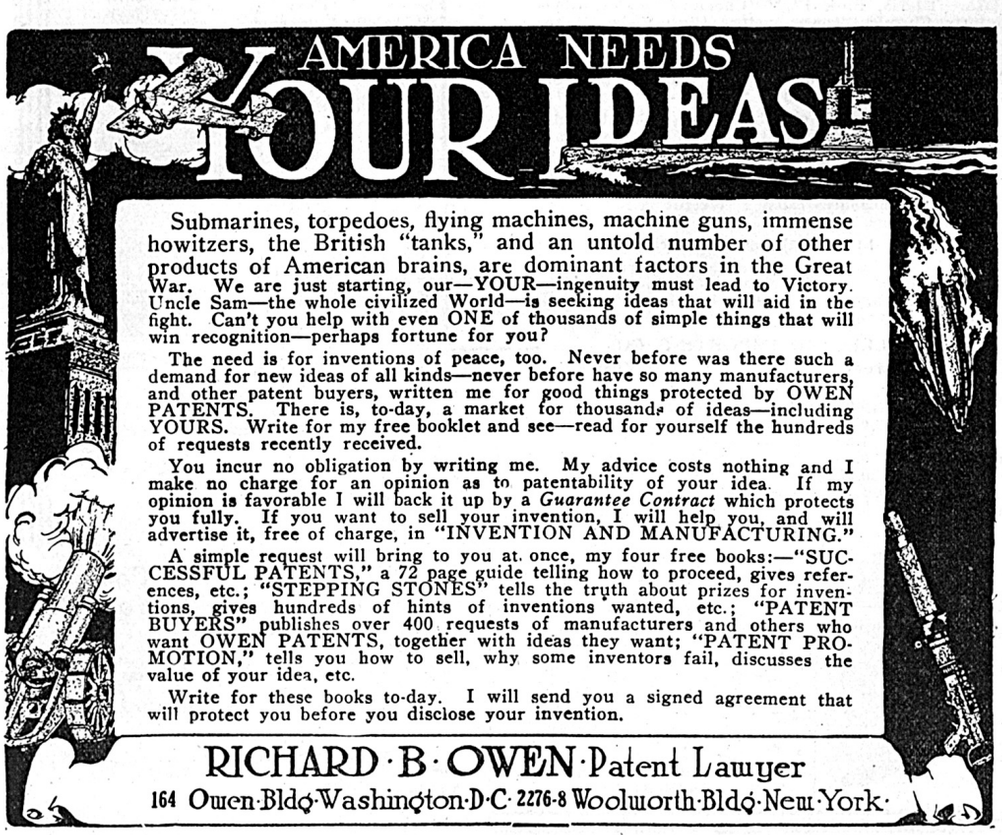

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STARCHED CLOTHES SPRINKLER.

(203) Mrs. Leslie McNeill, Corpus Christi, Texas, has submitted an idea of a water sprinkler to be used in sprinkling starched clothes. The idea in brief is a sort of portable tank with a spring attachment which when pulled, will sprinkle water from the bottom of the tank.

A. While the idea is feasible, we think it is far too complicated for a household utensil of this kind. It seems to us that the average housewife would not wish to invest any money in a device of this kind when an ordinary cup or sprinkling-can can be had for much less money. Anything that runs to simplicity and low price is sure to win out over more complicated ideas nowadays.

COMBINATION ELECTRIC LOCK.

(204) Henry O. Wuelfing, Bloomfield, Conn., has submitted to us a very interesting idea on a combination electric lock, particularly for use in preventing automobile thefts. The lock from the outside appears the same as an ordinary safe-lock, but in place of the usual steel tumblers, fiber gears are substituted which must be turned in a certain position in order to close the circuit, the correct locating being done by turning the dial back and forth to certain numbers.

A. This is a very good idea, and we are almost certain that nothing like this exists at the present time; we are convinced that a patent can be procured on this invention. As a precautionary measure, however, we would advise our correspondent to get in touch with a patent attorney in order to have a search made in the patent office.

GAS STOVE.

(205) Joseph F. Tucci, New York, N. Y., has sent in a sketch of a gas stove, the principle of which seems to lie in so-called forced draft, also making use of the principle of a Bunsen burner. This stove throws the heat out by means of a hood-shaped top, which also serves the purpose to throw the heat forward instead of upward. The inventor claims that he thus corrects the faults of present gas stoves.

A. This device appears quite plausible on paper, but without having it tried out, we are at a loss to know whether it will actually work as described. We would advise our correspondent to have a model made and if it works satisfactorily, to have a search made for patentability.

DOUBLE ENVELOPE.

(206) Williams E. King, Monesson, Pa., submits a very ingenious and what he calls a double envelope, made from a single piece of paper. The double envelope is supposed to be used for contributions in churches and elsewhere without confusion as to the donation. Our correspondent wants to

ADVICE

H. GERNSBACK.

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know if such a device is of any value, and if it could be patented.

A. The idea is very clever and seems quite feasible. We have seen a double envelope before, but not made as described by our correspondent. We would for this and other reasons recommend a search in the patent office; any patent attorney will be glad to conduct such a search at very low cost.

DYNAMO.

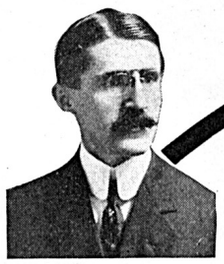
(207) Julius Gernot, Maurer, N. J., has sent us sketches as well as description of a dynamo armature, which he thinks will save not alone an enormous amount of energy, but will *almost* run free, thereby producing free energy! His contention seems to lie in the assumption that bringing the windings to a certain position on the outside of the armature, no power will be used in so transposing the windings. Our advice is asked.

A. Our correspondent labors under a delusion, and his machine will certainly not work as he states. It doesn't matter if the winding of the armature is outside or inside, if current is produced he must have just so much energy to do it, and this energy cannot possibly be cut down. Our correspondent also seems to think that it is the field coils which absorb the energy, and for that reason, he suggests some changes in the field coils as well. This, however, is not correct either, for the simple reason that if you take a magneto which has no field coils it does not work any different from a dynamo with field windings. If the magnetic flux is cut by the windings of the armature, so much energy must be supplied to the driving pulley in order to get so many watts. It doesn't matter how the windings are arranged, and no matter how efficiently they are disposed, the difference in the power factor saved is very small.

ELECTRIC NON-FREEZING DEVICE.

(208) J. D. Browder, Jr., Canadian, Okla., has submitted an electric non-freezing arrangement, whereby he uses a certain number of thermostats which control a heating element of an automobile radiator. The idea being that as soon as the temperature goes below 32 degrees Fahrenheit, the heating element keeps the radiator from freezing.

A. A very clever idea and seemingly cheap enough as a commercial article to be placed upon the market, where we think it would find a ready sale; we believe there is a distinct advantage of having a device of this kind. Nothing like this seems to exist at the present time. We think an idea of this kind is patentable.



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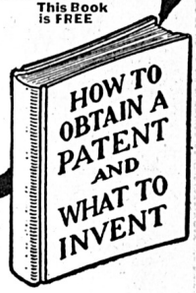

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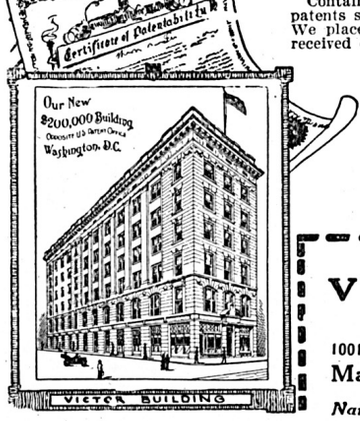

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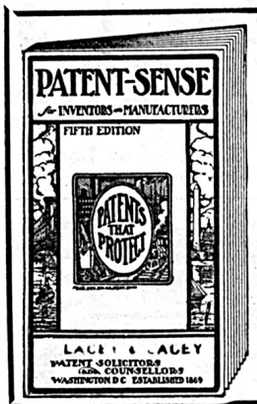

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THE THIRD LIBERTY LOAN AND YOU!

(*Continued from page* 751)

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The Third Liberty Loan affords a chance for the electrician at home to stand by his associate under arms. The loan not only will buy clothing and food for the man in service, but will help to equip the submarine chasers, the aero plants and the communication systems in which that associate of his is rendering expert help to the Government.

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(*Continued on page* 798)

THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 766)

Several other forms of condenser are illustrated in Fig. 4-A, B and C. That at A is the familiar rolled type of condenser. These are formed of one or more dielectric layers, made long with respect to their width, and which are suitably interleaved with two or more metal charging leaves; the whole is then rolled up and tightly comprest after having been soaked in hot paraffin wax. This gives a high capacity in a small space, and enables a large capacity condenser to be quickly constructed. Substantial terminals for such a condenser are formed of small copper strips about ¼ of an inch wide, which are wrapt in several turns of the tin-foil leaf at the end as Fig. 4-A indicates; this junction may be riveted. Where a fixt tin-foil and waxed paper condenser is used, and there are a large number of tin-foil tabs to be joined together, a very efficient and substantial connection is afforded by simply punching or drilling a hole thru the tabs and passing a battery terminal screw thru the opening formed and placing on either side of the tin-foil tabs a piece of copper or brass about ½ inch square. When the nut on the screw is tightened up, the tin-foil connections will be clamped firmly, and the connecting wire from the circuit may be fastened between two nuts on the screw or else soldered to the screw as desired.

An interesting *roller type* of variable condenser was invented some years ago by Mr. H. Gernsback, and this is shown schematically at Fig. 4-B. Three porcelain rolls are used in this scheme A, B and C. The three rolls are geared to each other by means of gears secured to the shafts of each roll, but which are not shown for the sake of clearness. A thin as well as flexible sheet of copper or aluminum foil as also a strip of flexible insulation, such as oiled linen or oiled silk is secured to roller A at the left. These are also secured to roller B as shown, and a second strip of flexible metal foil makes connection to rollers B and C. When the adjustment knob secured to the central roller B is turned, it unrolls the dielectric and one copper electrode from A, and also the second copper electrode from C, while a gradual increasing condenser capacity is produced about the perifery of roller B. The arrows in the drawing indicate how the rollers turn when the central knob attached to B is rotated either to the right or to the left. increasing or decreasing the capacity in consequence.

The diagram at Fig. 4-C shows how a variable air dielectric condenser may have its capacity increased several fold by filling its container with oil. One of the best oils to use for the purpose is castor oil, which has a "K" value of approximately 5. Thus, if the variable condenser with air dielectric has a capacity of .001 m.f., when it has its container filled with castor oil, its capacity will be increased to about .005 m.f. This property is made use of considerably in the laboratory, either for the purpose of increasing the capacity of the condenser or for increasing the resistance between the plates, and thus cutting down brush discharges and other leakage, where it is desired to use such a condenser in experimental *Poulsen Arc* circuits, etc.

A special form of high capacity, small size rotary variable condenser used by one of the leading commercial radio companies in their receiving sets and measuring instruments, as well as wave meters, is shown in section at Fig. 5-A. This variable condenser has about five times the capacity of an equal size air dielectric condenser, for the reason that it employs hard rubber as a dielectric instead of air.

The stationary semi-circular plates are covered with thin discs of hard rubber as illustrated, and the moving semi-circular plates slide in between the hard rubber leaves in the usual manner. The reason for the greatly increased capacity of this type of condenser is due to the high specific inductivity of hard rubber, which is about 5. Another interesting form of condenser which has been used both in this country and abroad to some extent, but which must be built very accurately to be reliable and free from accidental short-circuits, is the vertical, cylindrical plate condenser illustrated in plan view at Figure 5-B. As becomes evident the central rotary knob and shaft carries a suitable rigid member to which is fastened at either end a set of properly spaced, cylindrically curved plates which, as the knob is turned, intermesh with the similarly curved stationary plates, and thus increase the capacity of the condenser until they are moved thru 90 degrees. The capacity is reduced by turning the knob so that the moving plates slide out from within the fixt plates.

It is often desirable in building wave meters and in certain forms of receiving sets to obtain an extra high variable capacity. A common method of accomplishing this result is indicated at Fig. 5-C. A small or medium size variable condenser VC, is connected in series with the circuit, and in shunt with this variable capacity there is placed a group of small fixt condensers of the desired capacities, arranged with a multiple-contact switch similar to that shown in Fig. 3-C or one comprising

a metal sector as shown at Fig. 5—C with a series of spring contact fingers. Thus suppose the variable condenser VC has a capacity of .001 m.f., and that each one of the five fixt capacities shown has a similar m.f. value. It is thus clear that we may now obtain any capacity from practically zero up to and including .006 m.f. by intermediate stages.

The standard connections for both fixt and variable condensers are given at Fig. 6-A and B. A fixt condenser is usually connected in series with a detector as shown at Fig. 6-A, and is sometimes called the "stopping" condenser. The high resistance telephone receivers used with this circuit in connection with a crystal detector D, are frequently shunted across the fixt capacity as at Fig. 6-B. Either connection of the telephone receivers serves equally well in a majority of cases, but if the capacity across the 'phones is adjustable or variable, it is considered best practise to connect the 'phones across it instead of the detector, as considerable tuning can be done in this way and maximum strength of signal obtained.

Referring to Fig. 6-B, a standard connection of the variable condenser is across the secondary of the loose coupler LC. The variable capacity thus shunted across the secondary not only permits the closed oscillatory circuit to be adjusted to resonance with the open aerial circuit, but also permits a closeness of adjustment or tuning which the usual secondary inductance switch does not give. In any case the oscillations set up in the secondary circuit by adjusting it to resonance with the aerial oscillatory circuit, overflow to the shunt detector circuit, where part of the current is rectified by the crystal detector D, indicated in the diagram, and is stored up in the fixt condenser. The charge which this fixt condenser accumulates during the time of a single train or *group* of oscillations, discharges thru the high resistance telephone receivers T, thus causing the diaframs of the 'phones to vibrate at a rate which corresponds to the spark frequency of the transmitting station.

A new use for variable condensers is shown at Fig. 6-C. There are here used in the rôle of a *capacity coupling* between the aerial and closed oscillatory circuits. The diagram shown is that described and illustrated in the latest edition of the "Naval Electrician's Text-Book" by Captain Bullard, Volume 1. This arrangement of capacity coupling in the place of *electromagnetic coupling,* which is used in practically all other receiving sets, is strongly commended by the U. S. Navy experts, and is claimed to be equally efficient to any form of electro-magnetic coupling for short wave lengths, and to be very much higher in efficiency for long wave lengths. In this hook-up, devised by Dr. Louis Cohen, formerly of the Bureau of Standards Radio Laboratory, the primary circuit is tuned to the incoming wave length in the usual manner. The secondary coil L-2 and condenser C-2 are made resonant to the same wave length. The aerial circuit energy is transferred from the one circuit to the other by means of the two *coupling condensers* shown and which are secured to a common shaft, so that they are simultaneously adjusted. These condensers are in no sense of the word tuning condensers, and do not vary the adjustments of either primary or secondary oscillatory circuits. They are used for no other purpose than that of transferring electro-statically the energy in the aerial circuit and circulating thru inductance L-1, thence to the closed circuit comprising inductance L-2 and variable capacity C-2, across which is placed an adjustable *stopping* condenser BC, crystal detector D, and high resistance telephones, T.

(To be continued)

The Breakers

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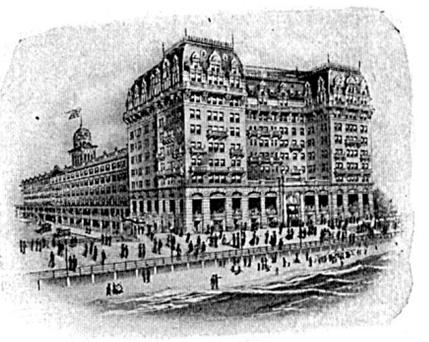

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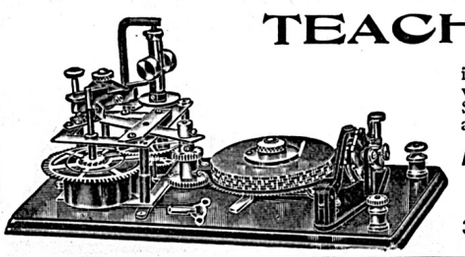

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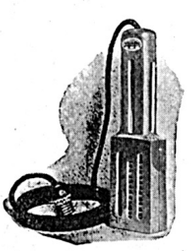

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THE THIRD LIBERTY LOAN AND YOU!

(*Continued from page* 796)

ment must be of the best. He must have instruments and dynamos that are better than those of the German who is up in the air on the same kind of assignment. All this requires money. That is where the American at home can co-operate with the man who used to work alongside him, and who now takes his life in his hands to search out the secrets of the enemy.

The German scientists who turned their thoughts toward war many years ago, devised weapons of destruction which they were quick to bring into action in 1914. British and French intellect, which had not been working in the same barbarous channels as that of Germany, was forced to imitate the enemy. It did not take many months for our Allies to catch on to this new and appalling game. By this time they have shown Germany how well they have learned the lesson she taught them in 1914. The United States has been forced to go to the same school. Here it was only a question of turning the unrivalled American genius for industrial invention in the direction of war. The nation has adjusted itself to battle conditions and will fight Germany, bomb for bomb, gun for gun, mine for mine, 'plane for 'plane, until the enemy lays down his arms and admits that he cannot finish what he started out to do.

The best intellects of the nation, hitherto employed in the diverse industries of the country, have been called into consultation by the Government. The Army and the Navy are getting the advantage of this "conscription of brains," as the assemblage of inventors at the call of patriotism may be called. The greatest minds may be diverted from private business in the laboratory and directed toward the mobilization of the mechanical forces of the nation; the most skilled workers in all the electrical trades may enlist in the Ordnance or the Signal Corps; every energy may be bent toward war; but unless the Third Liberty Loan is supported by the people as heartily as were the first two, all these efforts will be in vain. Men cannot fight without supplies and equipment. The Third Liberty Loan provides these essentials.

Thus the loan becomes the immediate concern of every man and boy in the electrical industries and in the experimental laboratories. It is no question of finance which has to do solely with the bankers or with the rich investors. Primarily it is a banking matter; yes, and it concerns the mobilization of billions in credit. But it also is the personal affair of every one in the United States.

The First Liberty Loan was over-subscribed fifty per cent., so that three billions were offered where two were asked for by the Government. The Second Liberty Loan was for a minimum of three billions, but more than four and a half billions were subscribed. When the Third Liberty Loan is opened, what will the answer of the Nation be?

An order has restricted the lighting of stores and restaurants in Berlin to one-fifth of the degree of illumination permitted up to December, 1916.

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Due to the congestion existing at the present time in all railroad movements, also on account of the fact that many train clerks have gone to war, there is a congestion of mails all over the United States. It will happen that your magazine may be slow in reaching you, and this delay may be from a few days up to several weeks.

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Attention Experimenters!!

VOL. 2, NO. 1. JANUARY 1918
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EXPERIMENTAL PHYSICS.

(*Continued from page 760*)

On comparing (a) and (b) in safe "red light" no difference will be apparent. One might hastily come to the wrong conclusion that light has no chemical effect on silver bromid, but if now a few drops of a weak solution of amidol, eikonogen, pyrogallic acid, ortol, or of any other well known developer are added to each of the test tubes (a) and (b) we find that (b), the one which has been exposed to the light, rapidly precipitates out fine black particles which gradually sink to the bottom. (See figure 56 (b).) Evidently the light has done something to it. Actually the light caused the silver bromid to give off a slight amount of bromin and percipitate out a minute quanity of silver. "Nascent silver" (silver just formed) causes the hydrogen in the "developer" to unite with the bromin of the silver bromid and thus leave the insoluble black silver particles. In the case of the ordinary "dry plate" or "film," silver bromid is mixed with gelatine (forming a more sensitive combination than the silver bromid alone, since the gelatine absorbs the bromin given off) hence aiding the liberation of bromin and the deposition of silver. The plates or films after being exposed show no change to the eye but when placed in the developer, wherever there was most light there will be most action, hence most silver and hence the darkest part of the "negative." Black objects, giving off no light do not affect the negative and the negative stays transparent (white).

This is illustrated by figure 57. If I is photographed the negative will appear as in II. Naturally one must remove the negative from the developer as soon as a clear image is obtained otherwise the entire amount of silver bromid would be decomposed and a black plate would be obtained. Practise enables one to know just when the "critical point" is reached. The process of "retaining the image" is not yet complete since if we were now to allow light to strike the negative the entire amount of silver would be deposited giving a black negative. This is eliminated by "fixing" *i.e.,* dissolving out the silver bromid by "hypo" (sodium thiosulfate) and washing, thus leaving the negative with no more silver bromid to be acted upon by the light. Now our image is fixt *permanently* on the plate or film and can be used for making prints, enlargements, lantern slides, etc.

The process of making *prints* or *positives* is essentially the same as that of making negatives. The negative is placed flat against the sensitized paper (paper with silver bromid and gelatine or albumen) and exposed. Thus light will pass thru the light part of the negative and not thru the black part of the negative in varying degrees, so that after developing the result is really a negative of the negative film or plate. Referring to figure 57 we see that the negative of II (which is the negative of I) is I (which is the original) so that our prints are exact copies of the original.

Experiment 64:—Different colors affect silver bromid in unequal degree. Blue and violet have a very pronounced affect while red and orange have almost none. It is because of this fact that the process of loading and unloading the camera and the process of developing are carried out in red light. To verify this, photograph various colored objects or better still a spectrum (see lesson 10, figure 52). It will be noticed that red appears black and blue white and the intermediates hues shade gradually from white to light gray, then darker gray, etc., up to black. If now a print is made of this negative the red end of the spectrum will be white and the blue end black with intermediate gray. The power of a light to affect the plate or film is called the *actinic* power. Since all colors do not have the same actinic power, ordinary photographs do not have *true* color values. This effect can be remedied by interposing *color screens* between the object photographed and the plate, thus reducing the sensitivity of the more actinic colors. A still better way is to use *orthochromatic* plates. These are treated with baths of certain dyes which increase the sensitivity of silver bromid for light of their own color. These plates, however, have the disadavantage of being slower than ordinary plates.

Experiment 65:—The process of making photographs in Nature's own colors has been a problem of Physics rather than Chemistry. There are several processes now in use for *colored photography* both for "still" and "moving" pictures, all of which depend upon the same physical principles of color. In lesson 10 we found that ordinary white light is composed of violet, indigo, blue, green, yellow, orange and red, and that if we mix these colors *white* light results. As a matter of fact if blue-violet red, and green (three primary colors) are mixed white light results.

One may satisfy himself of this fact by dividing a circular piece of cardboard into three equal parts, painting the segments with these three colors (see figure 58) and revolving the circular disk rapidly by attaching to a small motor. Because of persistence of vision the three colors will strike the eye at apparently the same time and the disk will appear white. In the most successful of color photograph processes, the glass plate is covered with an extremely fine layer of starch grains (almost microscopic in size) some colored red, others green, and still others blue-violet, *i.e.,* the primary colors (see figure 59). The mixture appears to the eye as *white*. Upon this mixture a layer of gelatine and silver bromid is spread. Since each colored starch grain can transmit only its own color of light it is evident that the silver bromid behind each red grain will be affected only by red light and a similar result is true for the other two colors. In order to form a positive immediately, the silver is dissolved out and the silver bromid decomposed into silver. Therefore where light from a red particle struck the plate the silver bromid was changed to silver, and then the silver dissolved out, so that the plate is transparent and on looking thru it one sees the little starch grain, *i.e.,* the same color as the object. The same holds true for the other two colors. On looking at the whole plate after development and fixing processes similar to those of black and white photography, the transmitted light will fuse the almost microscopic spots of color, and one sees the image of the object in Nature's own colors.

In *motion picture* work the same principle (primary colors) is used. The negatives are taken alternately (on black and white film) thru *red, green and blue-violet screens,* thus getting pictures of the red, green and blue-violet parts of the objects on separate films. On projecting the films, a screen similar to the disk of figure 58 is revolved in front of the film synchronous with the placing of the three films in position, so that the film of the red parts of the objects is projected thru the red screen and similarly for the others. By the *persistence of vision* these are blended, thus giving the natural colors. This phase of motion pictures is still in the experimental stage and a fortune awaits the one who develops a good commercial method, especially a method making it possible to take motion pictures in artificial light. May success reward the efforts of the conscientious workers in this field.

(*To be continued*)

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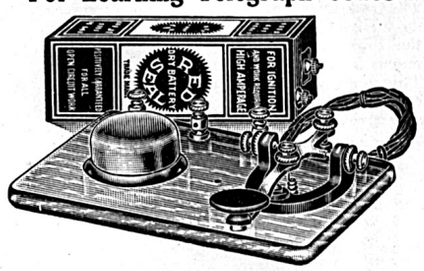

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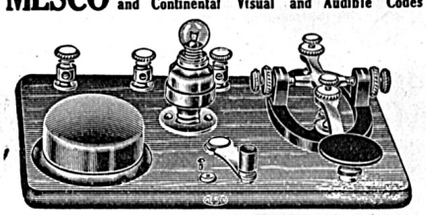

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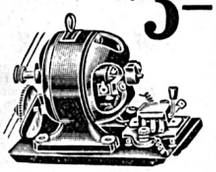

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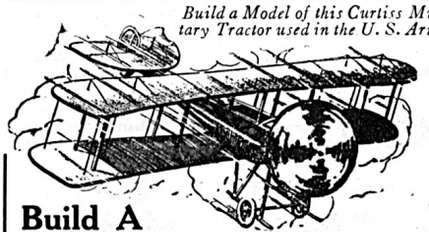

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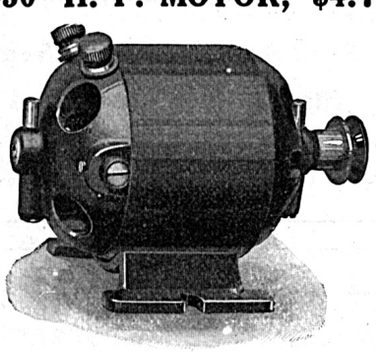

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VISITING ARLINGTON VIA THE TALO CLUB.

(*Continued from page 763*)

into the receiving room, and while watching the outfit work we saw the chap outside cut the other fellow off and start to operate the relay by hand. Afterwards we found out that the chap in question had the day before been on duty receiving and had taken his message from a boat, to be relayed later on, and that the fellow who did the sending at the time, made a mistake, so that was the reason for breaking into the transmitting. Some stunt, say we.

Along about this time "noon" began to pay us a visit and, of course, great interest was taken in watching how the 100 K.W. set was started up. One operator throws in a switch and the ammeter climbs to 300, and nothing happens; then somebody else grabs hold and at last the outfit gets into working order, but it took five minutes to speed up and say, 42 cm. gun-fire has nothing on the noise from the spark when the key is prest. One needs cotton in the ears, and then some, for when you stand ten feet away and attempt to talk, it's a case of yelling your head off, and ten to one the other chap don't get you. It is claimed that the spark can be heard two miles away on a quiet night, and one of the operators told us that when he goes to see his girl he never needs his watch to let him know when it is ten o'clock.

"Woody" wanted to get a picture of the back of the small switchboard, and as he owns a Graflex camera, we were afraid that the noise of its going off would inform the operator who would, no doubt, demand the film, for at that time some publishing company had bought the rights to take pictures, so there was nothing doing in the line of amateur photography, but he told me about his desire, and while he beats it back of the board I motion "Mac" and "Dickey" to come over and talk to the operator on duty *real loud,* thereby hoping to drown out the sound of Woody's "gun," for by the time the glass plate drops out of the way and the shutter film moves over the negative and three or four other things happen, bystanders know it because of the various clicks and groans. Everything worked fine except that when developed the picture was *no good,* as the light was bad, altho to use the words of another member, "Look at all the fun we had."

Going outside to watch the antenna "spark," which it *didn't,* we found the famous aerial switch mounted on two short poles with a ship's bell attached (see photo herewith). 'Guess they ring the bell when signals come down the lead-in. The switch consists of a carriage moving on two rails and controlled by wires passing thru holes in the receiving room wall. This gives three positions, namely, *grounded, transmission* and *reception,* and is really a very clever stunt. I almost forgot to say that before coming outside we inquired if it were possible to go up one of the towers, and the answer we got was to the effect that if we could get one of the men to go with us, why go ahead. So far, so good; but when we glimpsed the small stair-way with hand-rails only six inches high and nothing but air surrounding, Oh! Boy! we thought of Home and Mother and mutually dropt the subject.

Two of the towers are four hundred feet high, and the other six hundred, so you see it would have been some climb, and besides we all wanted to get back again the same day, for I guess that it would have taken at least an hour to climb and do it without dropping on the way up.

There was a small aerial running from midway the highest pole down to the station and this was used for six hundred meter work, as the large antenna has a natural period of about *two thousand meters.* In some way or other we started to argue about the number of wires in the aerial, and I nearly bent double trying to count them while "Woody" snapt a picture of me. 'Bet the fellows thought I would topple over, but luckily my stabilizer was working and I regained normal position again. The large aerials were pulled up by means of a steam roller and it was done by pulling up about two hundred feet, and then coming back for another hunk. Pieces of wire lay around and we all brought back a souvenir.

The wires from the telegraph companies and Washington Observatory were connected in the receiving room, for it is, no doubt, known that the time clock that closes the circuit for both Arlington and Key West, Florida, is in the Observatory and operates both stations simultaneously. Beyond this was a large room where there were going to be kept various styles of receiving sets and form a sort of museum while in one corner was a box full of Audions; afterward I told "Dickey" that while neither one of us would steal money the temptation to walk off with a couple of those bulbs was very strong and he certainly agreed to the fact. It's a funny thing tho when you look right into it and I suppose it is born of the training that an Amateur receives, namely, that radio sets need good detectors and also that every scrap of material must be saved in order to make new sets.

Our time was now getting short, so taking a last look we beat it for the car which could be seen coming some distance away, and upon arriving at the Monument, the motion on the floor was carried and we started skyward. "Woody" and "Mac" walked up while "Dickey" and "yours truly" rode, but as it takes five minutes to travel the five hundred feet we had a nice rest and would have gone to sleep only at the start the cables that held the car being so long, the car oscillated up and down a few inches and we thought something was going to happen. We could hear "Woody" and "Mac" yelling as they climbed round and round on their journey upward and we mutually thought that we for once possest the brains.

The top was reached, but Ye Gods! when you look down it almost makes you forget the Continental Code and "Woody" almost lost his hat, hauling his head back in again for the windows are small, but I grabbed it and very near lost my own. Postal cards were written and mailed at the top, but say, getting back to Arlington, one only appreciates the size of the towers when seen from the Monument, for it looked just like a gigantic spider about to use the Monument for a toothpick. The view from the top is great and well worth seeing, because it gives a clear idea of how Washington is laid out and with a little imagination it is easy to think how it feels to be an aviator.

Upon coming down we started back for the station and on the way "Woody" and "Mac" took in the Museum while "Dickey" hunted up the White House and I kept on till I hit Bryant's "eats dispensary" and satisfied my 5 m.f. condenser, afterward going to the station and waiting for the rest of the bunch to follow.

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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 780)

of oxid, and then hung in a solution of a salt of the metal to be deposited; a strip of the metal—gold, silver, or nickel—is suspended in the solution as anode, to keep the bath from deteriorating. (See Fig. 106). For gold or silver the bath usually contains potassium cyanid (KCN) together with a little of the salt of silver or gold (AgCN), etc., forming a double cyanid (KCN. AgCN). The current employed is furnished either from a dynamo or battery, and varies in voltage according to the metal deposited.

By way of illustration: In nickel plating we begin with 5 volts, gradually decreasing the current to 1 volt; for silver plating 3 volts potential is employed with a strength of 50 amperes per square meter of cathodic surface; in gold plating the E. M. F. should not exceed 1 volt and the current strength 10 amperes per square meter of cathodic surface. The time of immersion varies according to the metal to be plated, the metal deposited, and the thickness of the desired deposit. For nickel plating with a battery current, the time is from two to six hours; for silver, from eight to twelve hours; while gold requires but a few minutes immersion.

Due to the tendency to peel, heavy plating should be guarded against. Before such base metals as zinc, pewter, etc., can be plated with nickel or silver, they are given a light coating of copper, the object of which is to secure firm adhesion of the plating metal.

Electrolysis.

Most electrochemical processes involve *electrolysis,* the simplest illustration of which is the separation of water into its elements. Water was stated to be a non-electrolyte; it can, however, be electrolyzed indirectly for an experiment as follows: a small amount of sulfuric acid—which is an electrolyte—is first mixed with the water, which is then poured into the electrolytic apparatus and connected with the source of electricity, which may be two or three Daniell cells, these being the best for this purpose; or it may be connected, using a motor-generator, with a street current. A motor generator giving a maximum voltage of 15 and an amperage of 15 is of sufficient size. The electrolytic tubes should preferably be graduated. When the current is turned on it will be noticed that the gases collect unequally, about twice as much at the cathode as at the anode. A slight variation is due to the greater solubility of oxygen than of hydrogen in water. After running the current for a while, with a lighted splint test the gases which escape. Hydrogen collects at the cathode and oxygen at the anode.

Primarily it is the acid that is electrolyzed. The solution first contains $\overset{++}{H}\overset{--}{H}$ ions and $\overset{--}{SO_4}$ ions. When the current passes, $\overset{++}{H}\overset{--}{H}$ ions become H_2 molecules at the cathode and rise thru the liquid. The SO_4 ions at the anode become SO_4 radicals and break down into SO_3 and O. The oxygen rises as a gas thru the water, the SO_3 (being the anhydrid of sulfuric acid) unites with H_2O and forms H_2SO_4, which is again ionized into $\overset{++}{H}\overset{--}{H}$ and $\overset{--}{SO_4}$ ions, to again go thru the same process. Thus the end products are hydrogen and oxygen, and the water indirectly has been electrolyzed. The acid remains unchanged in quantity but it is really the acid that carries the current. In the electroylsis of all salts in solution water plays an important part.

Reduction of Metals.

Perhaps the most striking illustration of the reduction of metals by electrolysis is the preparation of aluminum as it is now carried on at Niagara Falls, where nearly 5,000,000 kilos (1 kilo equals 2.2 lbs. approx.) are annually produced by the famous Hall process. The principle involved is not dissimilar to those described above, the greatest difference being in the solvent and the kind of electrodes. A large iron box is lined on the sides and bottom with a mixture of carbon and coal tar, which forms the cathode (See Fig. 107). Large carbon terminals suspended from rods connected with the electric supply form the anode. The "bath" consists at first of solid cryolit (Na_3AlF_6), or a mixture of cryolit and fluorit (CaF_2), which is put in at the bottom and around the terminals. When the current is turned on the resistance to its passage by the cryolit fuses the latter, after which the aluminum oxid (Al_2O_3), specially prepared from the mineral bauxit, impure $Al(OH)_3$, is fed in. It is first dissolved by the molten cryolit, and then electrolyzed into oxygen and the metal aluminum. The latter seeks the cathode at the bottom of the bath where, at intervals, it is drawn off; while the oxygen passes to the anode, some of it consuming, at the intense heat, part of the carbon and burning it to carbon monoxid and dioxid, which escape.

Many other metals are now reduced by electric processes, as calcium, arsenic, phosphorus, and even iron. Calcium was a cabinet curiosity a few years ago, listed at $10.00 a gram; but now, owing to electrolysis, sells at *cents* per kilo. It is quite possible that, some time in the future, iron ores may be wholly reduced by electricity.

Many of these processes are electrothermic, involving heat to a far greater degree than usual, electric furnaces being substituted for the bath described above. The heat in these furnaces runs as high as 3,500 to 4,500 degrees. Moissan was the first, or at least one of the first, to utilize the process and invent a furnace, about 1890. This first attempt is illustrated in Fig. 108, and is a general type of most electric furnaces. It is about the same thing as an electric arc light placed horizontally and inclosed. Intense heat generated between the carbon terminals or electrodes by the passage of a current is made use of to melt, to vaporize, to reduce or to combine substances. Refractory elements like platinum, gold, copper, silicon and carbon are fused and even vaporized. In this furnace Moissan made minute diamonds from ordinary black carbon, the diamond being an allotropic form of carbon (see lesson on Carbon). The substance to be acted on, usually in the form of a powder, is put into the central open space between the terminals, the space closed, and the current introduced.

Carborundum.

This product, next to the diamond, is the hardest substance known, and was prepared by Acheson, but its chemical properties were investigated by Mülhauser in 1892. It is now made by million of kilos (1 kilo equals 2.2 pounds, approx.) annually. Its manufacture involved a very simple process, a reaction of silica (SiO_2) and carbon, the latter combining with both silicon and oxygen.

$$SiO_2 + 3C = Sic + 2\,CO$$

Carbon monoxid (CO) escapes thru the loose openings and burns, with the characteristic blue flame, to carbon dioxid (CO_2) on reaching the air. The carborundum (SiC) is left around the core of the terminals as a beautiful, crystalin, iridescent lustrous, metallic looking substance.

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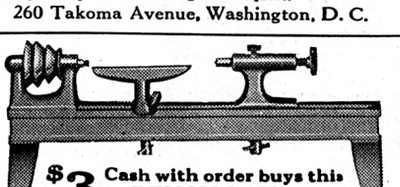

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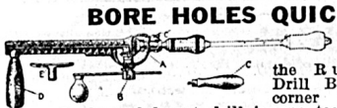

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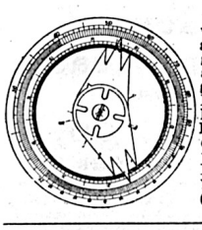

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The furnace is about 5 meters long, 2 meters wide, and 1½ meters high, built loosely of uncemented fire brick, and is dismantled at the end of each run. The carbons are 8 cm. in diameter and 60 cm. long, arranged in two bundles of about 60 carbons each. The charge contains 34.2% coke, 54.2% sand, and 9.9% sawdust, and 1.7% sodium chlorid (common salt), the total weight amounting to 10 metric tons. The conversion takes about 36 hours and produces about 2 tons. The core consists mainly of grafite around which is a layer of the crystallin carborundum, some 45 cm. thick.

Carborundum is used in all sorts of abrasive work from the polishing of granite to dentistry, taking the place formerly occupied by emery and corundum. Acids have no effect on it.

Calcium Carbid.—(CaC_2)

A substance which seems liable to revolutionize gas lighting is one of the largest furnace products. Slaked lime (CaO) and coke (C) are mixed and put into an electric furnace, the terminals in which are, as usual, carbon. A temperature of 3,300 degrees is obtained, at which the lime melts and the carbon reacts with it, combining with both calcium and oxygen, the latter forming carbon monoxid and carbon dioxid escaping. The calcium carbid is at first liquid at the high temperature, then is obtained in lumps of gray, earthy appearance.

$$CaO + 3C = CaC_2 + CO$$

The process was invented by Moissan and also Willson, the carbid having been accidently discovered in 1894 by Moissan.

When calcium carbid is thrown into water it reacts violently with it, liberating the gas acetylene, which burns with a brilliant white flame familiar to most readers, uniform thruout, entirely devoid of the non-luminous parts of the ordinary gas flame.

$$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$$
$$H_2C_2 + 5\,O = H_2O + 2\,CO$$

Acetylene is much in use for lighting headlights on automobiles, but is being gradually superseded by the electric lights to a very marked degree. It is also used in many places for lighting streets and houses, the gas being liberated in small definite quantities by water trickling on the carbid. It burns with a very smoky flame unless used in a special burner. Being an endothermic compound, acetylene easily explodes when under great pressure, dissociating into its two elements. It is non-poisonous.

The preparation of caustic soda by electrolysis was taken up in the Lesson on Sodium and Potassium Hydroxid, and little more need be said here about this process.

CHEMICAL UTILIZATION OF SUN'S RAYS.

That these electrochemical industries, and many others that might have been mentioned, have centered near Niagara Falls is due to the drop of 150 feet or more of the vast body of water of the Niagara River. For ages all the tremendous energy of this gigantic falls was wasted. A few years ago the idea was conceived of turning a small portion of the water into a canal, a mile or so back from the main falls, making an artificial drop, by excavation in the earth by the side of the river. Machinery was installed, the water conducted vertically downward thru penstocks, and turbines placed at the bottom, which the 25 meters of falling water with its enormous energy set in motion. This energy is communicated to the surface by revolving shafts and there used to drive powerful electric dynamos. The water is discharged by a subterranean passage below the Falls (See Fig. 109). It was a magnificent scheme, the immediate success of which was so great that new companies were formed—so many as to threaten the very existence of the Falls, and Congress has now past a law limiting the use of the water. The electric current is carried for great distances, even running street cars 100 miles away.

Utilizing the energy of falling water—indirectly the radiant energy of the sun—begun at Niagara, is now carried on at other places where cataracts have been provided by nature. The recent utilization of nature's forces has enormously stimulated chemical industries and led to many discoveries of new chemical processes; for of all agents, electricity best lends itself to the generation of other forms of energy. In Canada, Switzerland, Brazil and other countries, great waterfalls are utilized in this way. It is even proposed to carry the electric current from the falls of Zambesi in Africa to Witwatersrand, a distance of 600 miles.

(*To be continued*)

PRESIDENT'S SPEECH TO WORLD VIA CABLE AND RADIO.

(*Continued from page 742*)

and thence to India and the East Indies. Another cable route extends from Durban, on the east coast of Africa, to Mauritius Island, thence to Cocos Island, to Java and the west coast of Australia, landing at Perth. New Zealand received the message via the Vancouver cable route.

One of the longest straight, uninterrupted cable routes is that from San Francisco to the Philippine Islands, via Honolulu, T. H., Midway Island and Guam.

Alaska, too, read President Wilson's memorable speech, thanks to the cable running from Seattle to Valdez, via Sitka. Over snow-clad mountains and valleys the message leaped along telegraph wires to the farthermost telegraph city in this part of the world—St. Michael, on Norton Sound. It swept across Norton Sound with the speed of lightning, thanks to the wireless system operating between St. Michael and Nome. This wireless link, belonging to the U. S. Government, is of considerable historic interest, as it was first built by the well-known American radio pioneer, Dr. Lee de Forest, in the early days of Radio.

Another frigid clime territory that has cable connection with the world, but not shown on the ordinary map, is Iceland. A telegraph line runs across Iceland and its cable route is via Shetland Islands, southward to Scotland.

Coming back to the Atlantic Ocean we find that at present the direct German cables from New York have been cut. These used to land at Emden and ran via the Azores, which tiny spots of land, far out in the broad Atlantic, serve to join together many of the most important, long distance cables of the western hemisphere, as a glance at the map shows.

It has been said that, after the war, the United States and Canada will have an open sesame in establishing trade connections with the South American countries. This presumption has often been based on the mistaken belief that the European countries would have to send all cable messages via New York, and thence to South America, via the New York direct cable to Colon, etc. In this way it was thought that, perchance, the American merchants would get the tips on commercial deals and beat the Europeans to it—or at least give them a run for their money. This is where many people deceive themselves, for there is multiple cable service to Pernambuco, S. A., via Cape Verde Island, to Lisbon and Cadiz, thence to London, Marseilles, Aden, and the Far East; not to mention the other ambitious empires in northern Europe, all of which are plentifully supplied with cable and telegraph connections.

CAN ELECTRICITY DESTROY GRAVITATION?

(*Continued from page 743*)

(having practically no mass) rested upon insulators. They were separated from the protective screen by sheets of glass and were *grounded* to it by heavy copper wires. The metal boxes were then charged in every way that the solid lead spheres had been, but *not the slightest change in the position of the suspended balls could be detected.* This would seem to prove conclusively that the "repulsion" and "gravitational nullification" effects that he had produced when the *solid* large balls were electrically charged, were genuine and based undoubtedly on a true *interatomic electrical reaction,* and not upon any form of electro-static or electro-magnetic effects between the large and small masses. If they had been, the metal boxes, with no mass, would have served as well as the solid balls.

Another interesting experiment was conducted with low frequency alternating current applied to the large lead spheres. Spring contact brushes were fastened to the wooden blocks supporting the large spheres as shown in Fig. 4, one brush on either side of the ball. This permitted sending current thru the ball from one side to the other. First, a direct current of 20 amperes was sent thru the two large masses, but no effect upon the suspended masses could be detected. Next, an alternating current of 20 amperes was sent thru the large masses, see Fig. 4, with the result that the gravitational attraction was quickly reduced to zero, and not only that but in 15 to 20 minutes the small lead spheres *had moved away over one-half as much to the opposite direction* as the distance they had been attracted originally towards the large masses. Thus gravitation had not only been completely nullified, but it was *actually reversed.*

AT WAR WITH THE INVISIBLE.

(*Continued from page 759*)

I had the eerie feeling of one who beholds an awesome vision in a dream, aware that he is dreaming and unable to rouse himself. All sense of reality vanished before that appalling devastation. The tide was setting in from the bay and the sullen waters brought a small wave lapping at my feet. There was a splotch of rusty sediment on the wavelet which, to my disordered imagination, had the appearance of blood. It might be from some of the innocents beneath the sea, I thought, and drew back shudderingly.

The worst feature was that no one had survived to tell of the disaster. Camden, directly across the river, could give no coherent account of what it had seen. In fact, it had seen nothing that could explain the mystery. At ten o'clock in the morning—it was Sunday, and the neighboring cities were smiling peacefully up at the sky—a sudden explosion shook the Earth to its very heart. Stunned by the shock, the residents of Camden were further bewildered by the shattering glass and the rush of wind that sent chimneys and roofs crashing to the streets. Those who were first able to look about saw a black cloud rising to a great height above Philadelphia. It hung there for an hour or more, and meanwhile the surge of angry waters could be heard rushing in to fill the void. When the air finally cleared, the terror-stricken people rushed to the river front and their hearts sickened within them as they beheld a troubled ocean rolling over the region where once their sister city had been.

Ingals and I discust the problem for hours, but could come to no agreement. The National Geological Society had already declared the cause to be a volcanic crevasse of prehistoric origin, a layer above which had given way beneath the city and dropt it to a great depth. I accepted the Society's solution as the only reasonable one, but Ingals scoffed at it.

"The Mars fever has gone to your brain," I told him in one of our disputes. "Supposing they could have slipt thru the V-plane blockade—an obviously absurd proposition—why didn't someone see them coming or going? And why didn't the *selenoid towers* indicate their approach? I suppose you know that the plates in those towers will record anything coming towards the Earth as soon as the sol-ray interference begins—and that's 2,000 miles up. Professor Bergerov explained that very clearly in this morning's *Times.* Surely, you're not going to maintain that they've learned to reach us without disturbing the sol-rays."

"I'm maintaining only one thing," declared Ingals, "and that's the utter assininity of relying on the security of the past. What do I care for your damned sol-rays? The same minds that discovered them can find a way to circumvent them. Instead of wasting time trying to prove why the Martians couldn't have done it, those scientists had better be devising something to prevent their doing it again. And they'd better be preparing urgently quick, too, for it's my solemn belief those world-murdering devils are making ready for another descent."

Ingals was right. Barely eight days after the complete obliteration of America's third largest city, there came hurtling thru the air the gripping news of the destruction of Ramillon, the proud capital city of Mercury.

The need for theorizing was gone. The Martians had plainly broken thru the apparently impenetrable blockade and were again wantonly on the rampage. But how? we asked ourselves desperately. What unknown force had blood-reddened Mars unleashed, that could reach across the incalculable space, unseen and unheard, and, more omniscient than lightning, select its victims at will?

The days that followed Ramillon's destruction were like a gruesome nightmare. Every city on the allied planets lived on the edge of an unseen abyss, cringingly awaiting the next bolt to fall upon it.

On Friday morning, November 10th, as London was emerging from the fitful sleep of a terrorized city into the broad, full sunshine of a new day, a series of short, sharp, ominous explosions were heard in the air above the National Gallery. In sudden alarm, those in the vicinity gazed upward. From out of a clear sky, a shower of thin, red, metal discs zigzagged fantastically to the ground.

The entire district from Oxford Street to the Victoria Station became at once a frantic bedlam. Stampeded humanity rushed for shelter, and with palpitating expectancy awaited the direful catastrophe. With fascinated horror they watched the bewildering missiles bound and rebound from street to sidewalk and roll clinkingly to and fro.

Five—ten minutes past. The scarlet messengers had ceased falling, and lay gleaming in the bright autumn sun like splotches of blood. Here and there some, more bold than the others, stept out of their hiding places, compelled by curiosity to examine these strange visitants from out of the nowhere. Gradually London drew a sigh of relief. Traffic and life swung again into motion. Nothing fearful had happened. The metal hail phenomena would soon be explained, perhaps, by those whose business it was to solve such freakish events.

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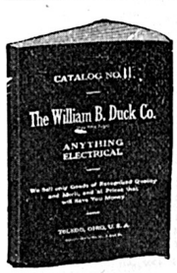

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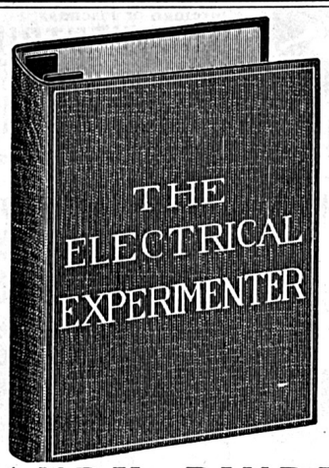

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Hardly an hour had past when London's feeling of reassurance was cruelly shattered. The discs, interpreted by university experts, were found to be messages from Mars. In one brief statement, the imprint on the red circle announced the complete destruction of the city by three o'clock that afternoon. A wail of deepest anguish rose from London's masses and spread like the blackened wings of doom over the whole city as the demoniac portent of the evil messengers penetrated the minds of the people.

In vain had the watchers in the Selonoid Towers sprung to their sensitive recording plates to seek for some indication of the enemy's presence. The plates were blank. A message, imploring help, was flashed over the Earth and at once our strongest forces were hurled to the spot. Huge V-planes, bearing tremendous batteries; grim little Heliolites (in one of which I was stationed) with their atomic detonators, and thousands of other craft thronged the air for a distance of five hundred miles around and above London.

But of what avail our formidable armament, when there was no visible enemy against whom to direct it? We circled about in close formation so that not even a sparrow could have escaped our reflectors, but the air was apparently innocent of any hostile ship.

Meanwhile, the city below was in the grip of a hellish panic. Those who could take to the air did so immediately, with never a thought for their treasures left behind. Others pushed and struggled like maddened beasts along the streets to escape from the doomed city. Bruised and crushed bodies lay thick along the highway, like worms after a spring rain, and their fellow beings trampled on them unheedingly in those awful moments.

Unfortunately, the greater part of those who cleared the city streamed out into Essex and Kent, overflowing such places as Welling, Grayford, Dagenhow, Grays Thurrock and Gravesend, where the Martians had evidently placed contact points for their detonators, in order to tear up the entire Thames bed and hasten the deluge from the North Sea.

A few minutes before the appointed hour we withdrew our army of planes with as many people as we could load on. I bent over the glass in the floor of my Heliolite for a last glimpse of London.

An immense throng had gathered on the Embankment, evidently resigned to the dreadful fate, and were listening to the soothing words of an old man who had assumed leadership of the mass and like some inspired prophet was evidently directing their thoughts away from the approaching terror. Down Cheapside way, other groups, crazed by fear, were tearing and rending each other in insane fury. My last impression—one that I still see vividly whenever I close my eyes—is of a large number of women and children kneeling on the ground in Regents Park, their arms outstretched piteously to us as we flew by.

So long had we stayed, loath to depart while there remained the faintest hope of discovering the Martians, that we had only reached Oxford when the explosion came. Again the dark cloud of destruction spread above the Earth, again the swirling waters rushed into the chasm, and London with its ten million lives was gone.

This was the culminating tragedy. Secure in her untrammeled power, Mars now issued an insolent manifesto. Peace was offered us on terms that would make the allied planets mere vassals to her will. If we accepted, the destruction of our cities would cease, otherwise—. Five days' grace were allotted us to make our decision. Unless we agreed to her demands by noon on Thursday, that hour would mark the doom of New York, and our other cities were to be similarly damned to extinction.

On the Saturday evening following London's destruction, I sat in the study of my apartment overlooking Van Cortlandt Park. My mind was spent from a whole day's heart-wearying discussion and argument in the Council. Many of the older men had advised submission, but several members of the Board of Strategy, including myself, pleaded for delay. At any moment the keen minds working tirelessly on the problem might discover the means used by the Martians to reach our Earth undetected. Without such knowledge, we all admitted, our cause was hopeless.

Alone in my room the mystery tugged at my mind again and again. It was baffling. In despair I looked about for something to relieve the unbearable strain. The *reflecto-screen* on the east wall caught my eye. It was connected with the leading theaters, and I remember thinking cynically how the people could go on playing even tho the end of the world was in sight.

Theresa Carmine was singing at the Metropolitan, I noticed by the *auto-indicator*. Switching off the lights, I connected the screen transmitter with the Opera House, opened the *audophone*, and stretched myself comfortably in an arm chair before the screen.

The second act of *Madame Butterfly*, that imperishable story of hopeless love, was nearing its end and Carmine stood looking towards the bay, waiting patiently for the lover who would never return. The wonderful colors of the screen brought out vividly the pathetic droop of the slim figure. and the room echoed softly to the sobbing violins and 'cellos of the orchestra.

Unstrung as I was by the events of these anguished two weeks, the pitiful little tragedy touched me deeply. Tears came to my eyes and I thought of Ava. I had been unable to see her since the night of the reception in Paris. Probably the next cataclysm would destroy one of us, I thought, and the other would be left alone, like the little Butterfly, waiting, waiting—

The curtain dropt and the sound of ringing applause came over the audophone. The operator at the Metropolitan now turned his *visu-flector* upon the audience. Row upon row of exquisitely drest women and men flashed on the screen. The sight of the smiling, chattering, thoughtless throng jarred on my mood and I was half rising to disconnect the transmitter, when the view of a box directly in the center of the horseshoe brought me to my feet with a cry of surprise. There sat Ava beside her father, a pensive smile on her beautiful face, her eyes shining straight into mine!

The view past in a second and I was left gaping at the screen. I had been so engrost in the Martian atrocities that I had entirely lost track of the Venusian commission's program. Undoubtedly this was the day of their arrival in New York, and of course the committee had taken the members to the opera.

In another minute I was up on the plane roof and had pushed my little electric from the garage. The despondency of my mood had changed to joyous exhilaration, and I rose high in the air before turning towards the Metropolitan. A young moon was high in the heavens and New York lay beneath me, bathed in the enchanting glow. Never had the city looked so beautiful, so entrancing; never had it seemed so dear to me. I was conscious of a sudden strong faith that it would be saved from the despoilers.

The last act had already begun when I entered the box. Quietly I drew a chair from the rear of the box and seated my-

self near Ava. Under cover of the darkness I prest my lips to her hand. I felt a thrill go thru her as she recognized me, and my heart welled up in contentment. Again I raised her hand to my lips. The mystic bells chimed faintly and Ava prest my hand warningly. I leaned back, silently drinking in the radiance of her presence. Idly my mind played with the thought of the bells on her wrist. Mysterious bells, I thought dreamily, ringing like our love from heart to heart, invisible to the world—

With a sudden jerk I sat upright. "Ava!" I whispered. "Come outside with me."

She turned in surprise.

"At once!" I urged breathlessly.

Obediently she took my hand and followed me to the foyer. It was deserted and I led her to one of the gilded settees, my mind tingling with the idea that had entered it.

"The bells—" I spoke in a choked voice, unable to control the eagerness that was thrilling me. "Let me have them—I must see—"

"I cannot take them off. No one knows how the bracelet is fastened." My excitement had communicated itself to her and she breathed rapidly. "What is it?" she asked eagerly. "What have you discovered?"

"I'm not sure yet, but I think—I believe—" A surge of exultation overwhelmed me and I clasped her to me so tightly that it seemed as if our hearts must meet. "Ava!" I cried. "You and I have found the secret of the Martian raids!"

"Where!" she gasped.

"On your wrist!" I replied triumphantly. In the excitement of the moment, wrought up by the discovery and the closeness of her own dear self, I kist her.

"Can the bracelet be touched?" I asked when we had sobered down.

"Of course. Here, give me your hand."

With her left hand she directed my fingers to a place on her arm. To all appearances the soft, white skin was absolutely bare and there was nothing to prevent my touching it; but with my fingers barely a half inch away, a hard object interposed itself. I could feel it encircling her wrist. It was evidently of glass or some other crystalline substance, and, to my cautious, exploring fingers the surface appeared broken into innumerable tiny facets.

"The bells are inside," Ava explained.

Blindly, as it were, I continued my investigations with finger tips alert.

"Where and how did you get the bell-bracelet?" I asked.

"A friend of my father gave it to me years ago. He was always experimenting with mirrors and stones. I remember his saying that some day he would be able to wear a coat that would make him invisible." A swift light of understanding illuminated her deep, opal eyes. "That is just what the Martians are doing!" she exclaimed.

I nodded. "Is that man still alive?"

"No. He was killed in an accident shortly after he placed the bracelet on my arm. That is why I have never been able to remove it. No one but he knew how."

(To be Concluded.)

A SPEEDOMETER FOR SMALL BATTERY MOTORS.

(Continued from page 770)

out when you pull the cord. Thread the other end under the staple, F, and up thru the small hole, g, in the arm, D. Connect the other arm up in the same manner. Tie the end of each cord to its appropriate arm, adjusting the length so that when the arms are up flush against their respective stops, e, Fig. 3, and the cord is taut, the slider will be about 1/16" from the outer ends of the guides, H.

The part P is a wooden standard, ¾" x ½" x 1⅝". To it are screwed the bearings, N, supporting the drum, M, by means of a small pin passing thru it and serving as a shaft, permitting the drum to revolve freely.

A good drum may be made by simply passing an ordinary pin thru the center of a cork. Be careful that the top of the drum is even with the center of the motor shaft.

Solder a short piece of No. 28 copper wire, L, to the end of the link, I. Pass it once around the drum and fasten the end to the pin, S, adjusting the length so that there will be no slack when the slider, J, is out as far as the cord, G, permits it to go.

The elastic band, Q (or better, a spiral spring if you can scare one up), is also fastened to the pin, S, and the other end fastened to the small screw-eye, R. The tension will have to be adjusted by experiment after the speedometer is completed.

O is a wooden standard, tapered at the top to about ⅛" in width. See Fig. 3. In height it should be just sufficient to barely support the link, I.

A tack, K, similar to those used in making cigar boxes, is placed thru the slot in I and driven almost home, but permitting I to slide easily back and forth without the slightest trace of binding. This arrangement permits the lateral motion of J to be communicated to the drum, M, and thence to the end of the pointer, while preventing I from turning with the motor and twisting off the connecting wire, L.

An old hat pin, cut to the right length, makes an ideal pointer. It should be pushed thru the drum so that when the motor is at rest and the tension, Q, is properly adjusted, the end will be at "stop" on the dial, V, which is supported by the standard, U.

X, X^1 are two small angle irons used to firmly fix the standards, P and U, to the base board. The screws in X^1 should be long enough to pass entirely thru U and the wooden block, Y, into P, thus fastening the three pieces firmly together.

Pins should be driven into the dial at W, W to limit the swing of the pointer. The whole should then be screwed to the base board at the proper distance from the motor.

The principle of operation is similar to that of a governor on a steam engine. As the armature revolves the weights tend to overcome the tension, Q, and fly out, thus pulling the slider, J, toward the flange, B. This lateral motion is communicated to the drum, M, and pointer, T, by means of the link, I, and wire, L. The faster the armature revolves the farther will the weights fly out, causing the pointer to move across the dial toward the left.

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THE FIRST TROLLEY.

(Continued from page 750)

controller handle while the brakes are released, the power will be automatically cut off, the brakes will automatically apply in emergency, sand will be applied to the rails, the front door opened, the steps lowered, and the rear door unlatched so that it may be opened by hand if desired. Should occasion arise for the operator to apply the brakes in emergency, the door and step, sand and brake operations are performed by the mere moving of the brake valve handle to emergency position, thereby making the operator's duties on such occasions as simple as possible.

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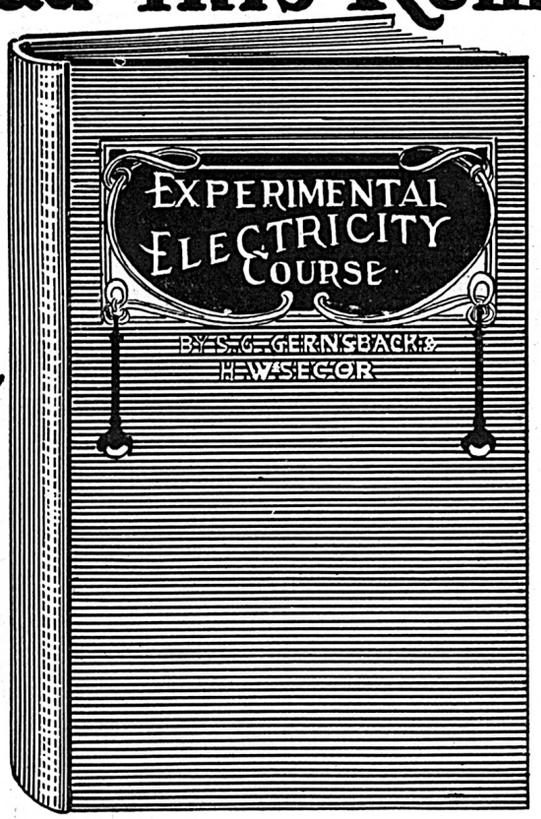

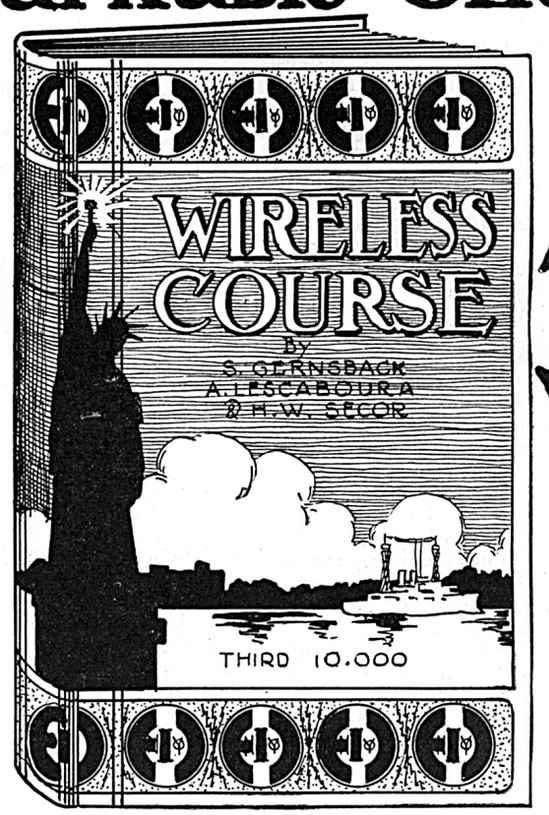

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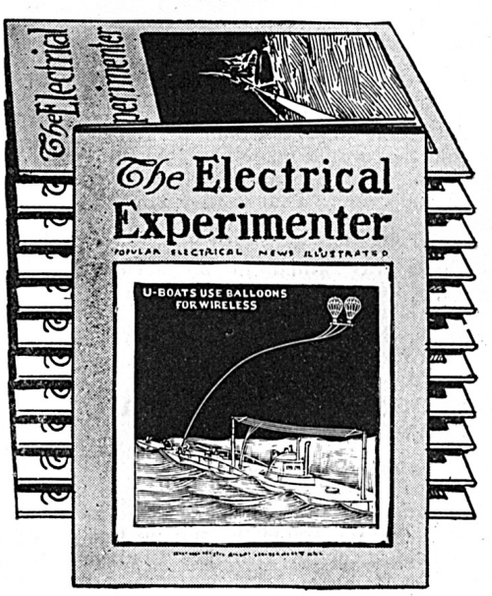

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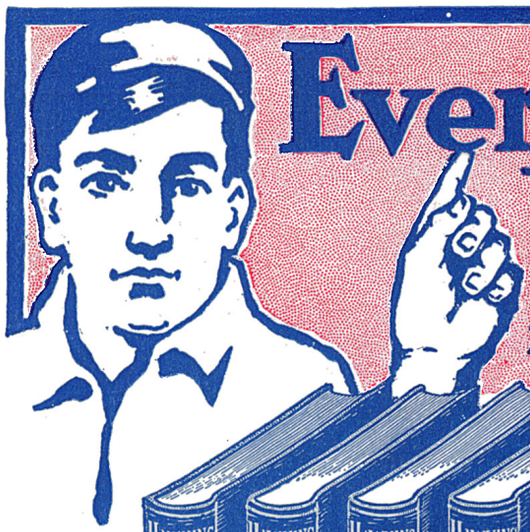

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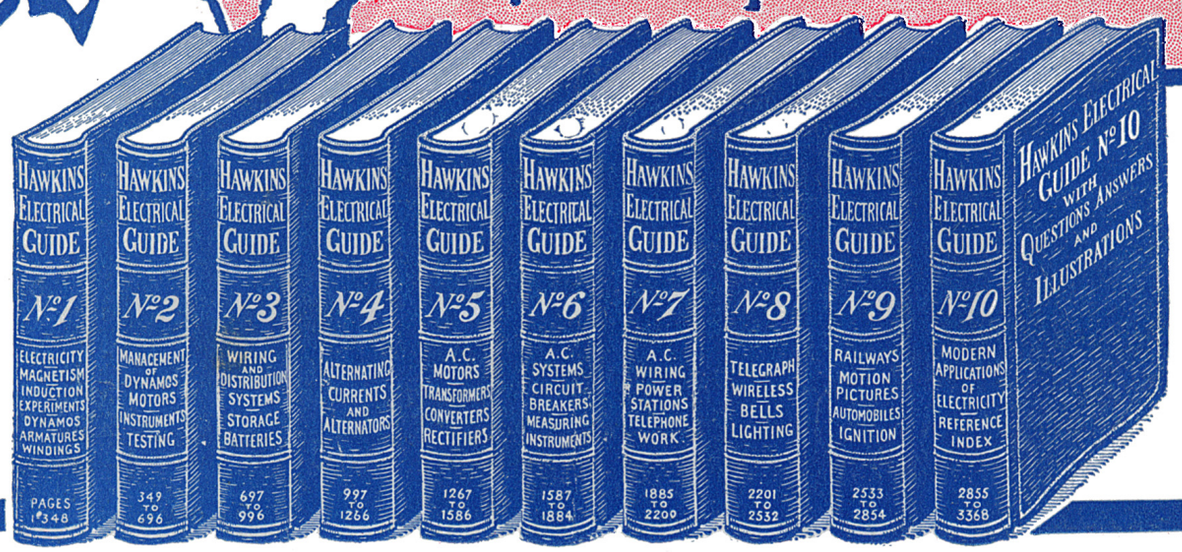

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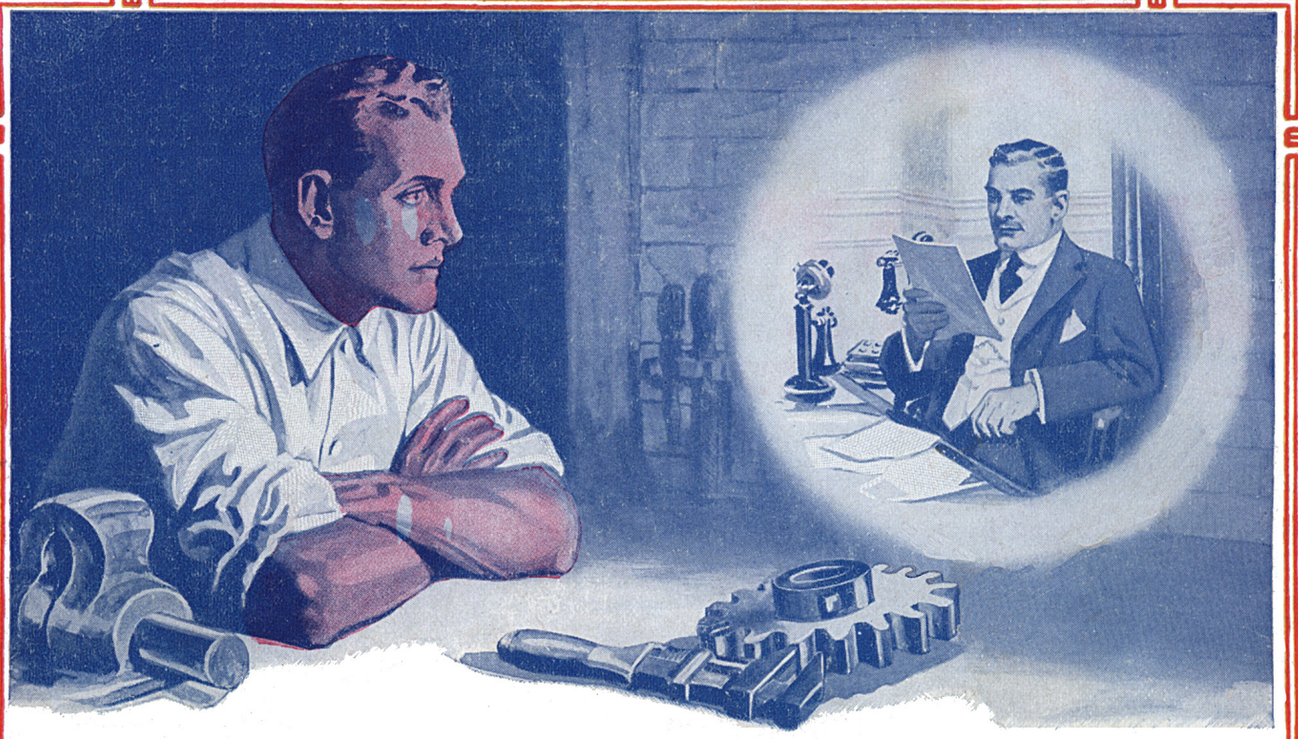

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